Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXVIII. FEBRUARY, 1925 No. 2

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Contracts Awarded

ROADS AND STREETS

Ala., **Montgomery**—State Hwy. Comn., Montgomery. let contracts for 7 miles Birmingham-Montgomery Hwy., Chilton Co. from Lomax to Autauga Co. line; grading, Gillis Constr. Co., Brewton, at $84,752; bridges to C. B. Cox, Clanton, at $52,440; paving to Morgan-Hill Constr. Co., Birmingham, at $229,814; Morgan-Hill Constr. Co., Birmingham, at $16,745 to grade and pave with concrete 1 mile Sec. C, Birmingham-Montgomery Hwy. through City.

Ark., **Van Buren**—Kaw Paving Co., Topeka, Kans., awarded contract at $108,092, for about 70 blocks paving in Paving Dist No. 3 and curb and gutter **Dist. No. 1.**

Ariz., **Phoenix**—H. E. Hoopes, Safford, awarded contract by Bureau of Public Roads for constr. of roadway on the Clifton-Springerville forest highway, at $67,634.

Cal., **Burbank**—Geo. A. Simpson, Olson Bldg., Burbank. awarded contract by City at approx. $350,000 for st. impvts. in Benmar Hills Tr. involving grading at 2c sq. ft. conc. paving at 23c sq. ft. Oil macadam at 11.75c sq. ft., curb at 55c lin. ft., walk at 18c sq. ft., $90,000 ltg. sys. compl. Jno. W. Henderson, 120 S. Glendale Ave., Glendale, awarded contracts for impvt. of Orchard Dr., Parish Pl., Lamer St., Leystone and other sts.

Cal., **Chico**—J. E. Johnson, 315 Stockton Savings & Loan Bank Bldg., Stockton, awarded contract by City Trustees for impvt. of Normal Ave., Hazel St., etc.: 581,040 sq. ft. grading, 575,200 sq. ft. 5-in. asphaltic conc. pavement, etc., at $114,580.

Cal., **Elsinore**—Hall-Johnson Co., 3025 Fowler St., Los Angeles, awarded contract by City at $103,-214.50 to pave Spring and other streets here.

Cal., **Hawthorne**—Oswald Bros., 366 E. 58th St., Los Angeles, contract at $181,660 for impvt. of Prairie Ave.—northern to southern City limits; 565,016 sq. ft. 2-in. Willite surf. on 4-in. asph. concrete base, 4-in. disint. granite sub-base; Geo. H. Oswald, 366 E. 58th St., Los Angeles, contract for paving New Jersey St., at $37,199.

Cal., **Los Angeles**—Chalmers & Ford, 532 H. W. Hellman Bldg., awarded contract for impvt. of 68th St.—Vermont to Normandie Aves.—at $67,802. Concrete pave.; L. A. Pav. Co., 2900 Santa Fe Ave., contract at $35,915 for impvt. of Oxford Ave.—Beverly Blvd. to 3rd St.—Topeka pave, etc., at $35,915; Geo. H. Oswald, 366 E. 58th St. contract at $22,304 for Topeka pave. in Parthenia St.—Gamut Pl. to Woodley Ave.—at $22,304; Geo. H. Oswald, also received contr. for cem. conc. pave. in portion of Plymouth Blvd.—$7,275, also contracts at $17,595 for impvt. of portion 41st Dr. and at $20,668 for cem. conc. pave. Warrenite pave., etc., on 41st St.

Cal., **Los Angeles**—Geo. R. Curtis Paving Co., 2448 E. 26th St., contract by County for following: N. 125, Flower St.—S. bound of Inglewood to Hardy St.—at $17,687; No. 229, 188th St.—Main to E. bound. of Los Angeles, excl. Moneta Ave., at $35,-837; No. 176, 94th St.—Main to Monea Ave.—at $12,727. Following street work contracts let by Bd. of Pub. Works, Los Angeles: Alpine St.—N. Bway. to Figueroa St.—to Warren Constr. Co., 2221 E. 25th St., at $58,740; Geo. H. Oswald, 366 E. 58th St., at $380,843 for Vermont Ave.—Manchester to 165th Sts.; W. D. McCray, 416 An. Bank Bldg., at $4,379, for impvt. of portion of Machado Ave.; alley w. of St. Andrews Pl.—48th to 49th Sts.—to California Paving Co., 1627 Cherry St., at $966; Denby Ave.—Blake to n. e. line Tr. 5485, to C. R. Snow, 852 Huntley Dr. W. Hollywood, at $2,198.

Cal., **Pasadena**—H. R. Erdman, 141 W. Main St., Alhambra, awarded contract by City at $2,841.15 for impvt. of Highland St.—Los Robles to Garfield Aves.—walk, grade, curb, gutters, etc.; also contr. at $761,681 for impvt. of Elmira St. betw. e. and w. lines Tr. 6425; Clarence P. Day Corp., Boston Bldg., Pasadena, contract for impvt. of Ella Ct., at $9,811; oil mac. pave., sewer, etc.; Ducey & Breitenstein, Pasadena, contr. for improvements of Division St.—Mich. to Hill Aves.—at $4,775; H. R. Erdman, contract at $1,479 for impvt. of Hiatt St., grade, curb, gutter, etc.; Ducey & Breitenstein, also contr. at $5,550 for impvt. of Peoria St.

Cal., **Sacramento**—Edwards Bros., 311 Pac. Mutual Bldg., Los Angeles, awarded contract by State Hwy. Comn., at $400,905 for State Hwy. in Shasta Co.—Halfway Crk. to Dog Crk. Work involves grading and graveling; approx. 310,000 c. y. excav.

Fla., **Groveland**—J. B. McCrary Co., Citizens & Southern Bank Bldg., Atlanta, Ga., awarded contract by Town to pave with brick and lay curb and gutter on abt. 2 miles of streets; also install storm sewers at $117,414.

Fla., **Lake Worth**—Robert J. Lassiter Co., Raleigh, N. C., awarded contract by Town at $120,-000 to pave 10 miles of streets and alleys; lay 20 miles curbs and gutters.

Fla., **Palatka**—T. B. Gillespie, Palatka, awarded contract for 50,000 sq. yds. vit. brick with asphalt filler street paving, at $138,876.

Fla., **W. Palm Beach**—Following contracts let by Palm Beach County Commrs.: 3 roads; East Coast Constr. Co., at $14,998 to improve Ocean Blvd. at Delray Beach and intersect. of Atlantic Ave.; build ⅞ mile Delray cutoff to McVay Lindsey Co., at $114,223 to grade, rock and oil Belvedere Road.

Ill., **Altmont**—Cole & Fanber, Marion, awarded contract for 13,734 c. y. excav., 38,361 sq. yds. 8-in. conc., 23,417 ft. conc. curb, etc., at $110,600.

Iowa, **Davenport**—Following contracts let: Paving, to Central Engineering Co., 809 Putnam Bldg., Davenport, for paving 9.788 miles primary rd.—Davenport S. W. through Buffalo, at $264,333; 50-ft. conc. arch 8 box culverts, to W. D. Phelan & Co., 313 Hazelwood Ave., Davenport, at $13,412; 40-ft. deck girder, 1 32-ft. I-beam brdg. to Henry Gertz, Eldridge, girder, at $5,455; bridge $3,250; 1 30-ft. arch to Federal Bridge Co., 1002 B. T. Bldg., Des Moines, at $6,761.

Iowa, **Des Moines**—Following contracts let for paving and grading in Polk County: Panora-Speedway Proj., 215 w. from Johnson Sta., to O'Rourke Engrg. Co., 1215 Mulberry; 7.324 miles; $292,168; White Pole Proj. 216, 8.4 miles to Wright Construction Co., at $354,309.

Kans., **Eldorado**—Thogmartin & Sons, Ft. Scott, awarded contract by Butler County for bitum.-filled brick surf. on F. A. P. 205-D, at $80,766; also contract for bitum.-filled brk. surf. on F. A. P. 205, Secs. A. B. C., at $68,198, $64,748 and $83,468, respectively.

Ky., **Alexandria**—Metzel, O'Hearn, Vastine & Lewis let contract by Campbell Co. Bond Comn. to complete 7.1 miles Licking Pike, at $248,000.

Mass., **Boston**—New Haven Road & Constr. Co., New Haven, award. contract by Dept. Pub. Wks. Div. of Hwys., for bitum. macadam paving; 17,333 ft. highway in Fairhaven and Mattapoisett, at $128,300; Lane Constr. Corp., Meriden, awarded contract for bituminous macadam pavement, 21,666 ft. highway in Framingham, Ashland and Holliston, at $85,599; 2,109 ft. highway in Whitman to Powers Bros., 161 Montello St., Brockton, at $15,347.

Mich., **Lansing**—Following State Trunk Line contracts let: Rd. 17-21, Wayne Co. Dearborn and Nankin Twps. Cl. G and DS. 6.591 mi. to Julius Porath, Detroit, Mich., at $178.268. Est. cost cement, $9,641.76 ; 17-16, Kalamazoo Co. Ross Twp. excav. spec. authorization, to State Constr., at $2,500; 13-31, Kalamazoo County, curves, spec. authoriza. to Kalamazoo Co. Rd. Comn., at $1,459.33. Fed. Aid contracts: 42. C. Wayne Co., Village of Flat Rock, Cl. F. 20 ft. wide, 0.305 miles, spec. authoriza. to Wayne Co. Rd. Comn., at $14,977.

Minn., **Hibbing**—E. W. Coons Co., cor. Grant St. and First Ave., Hibbing, awarded contract for 55 City blks. of paving. Approx. $300,000.

Miss., **Jackson**—State Highway Dept. let contracts for 2 roads: Sharkey Co.: 4½ mi. grading, draining and surfacing betw. Rolling Fork and Leland, to Morrow & Burt, Gunnisons, at $18,743; Marshall Co. grade, drain and gravel surf. 8.3 miles betw. Holly Springs and New Albant, to Nixon & Phillips, New Orleans, La., at $96,747.

Mo., **St. Louis**—Webb-Kunze Constr. Co., 5927 Fyler Ave., awarded contract for asphalt on concrete surfacing on Louisville St., at $33,221; Granite Bitum. Paving Co., Railway Exch. Bldg., Warrenite on conc. pave. Division St., at $29,491, Emerson St., $29,111, Thomas St., $25,341, Varrelman St., $5,772; Blackburn-Crean Constr. Co., Chouteau Trust Bldg., concrete pave., etc., Hoffman St., at $13,736, granite recut block repaving.

etc., Arsenal St., at $22,120.

Neb., Lincoln—Roberts Constr. Co., First Natl. Bank Bldg., Lincoln, awarded contract for impvt. of 40 blks. in various streets in 5 districts; 56,000 sq. yds. conc. pavement, 6,000 lin. ft. conc. curb., 14,000 lin. ft. conc. guttering, 19,000 c. y. excav., $140,000; 6,000 ft. 12 to 39-in. vit. clay sewer, $14,360.

N. D., Bismarck—Haggart Construction Co., Fargo, awarded contract for grading, paving and culverts on F. A. Proj. 244, Burleigh County, at $123,365; bitulithic pavement.

N. Y., Brooklyn—A. E. Castle, Inc., 3313 Tilden Ave., awarded contract for grading, curbing and flagging Kings Hwy., at $235,162.

N. Y., Brooklyn—E. Riegelmann, Pres. Borough, let contracts as follows: B. Picone & Son, for grading, curbing and flagging Brooklyn Ave., at $2,341, Schenectady Ave., $4,587, 9th Ave., $3,748, 80th St., $3,403; W. J. McHale Contg. Co., 1250 Jefferson Dt., E. 37th St., $3,588, E. 48th St., $4,262, to R. Lynster, 1364 Sterling Pl., Nostrand Ave., $2,098; Uval de Asphalt Paving Co., 1 Bway., New York City, aspahtl paving on Brooklyn Ave., at $3,498, to Brooklyn Alcatraz Co., 407 Hamilton Ave., E. 37th St., $7,864, Livingston St., at $109,503, 9th Ave., $8,774, 80th St., $8,805.

N. Y., Brooklyn—Following contracts let by E. Riegelmann, Boro Pres.: Granite repaving Sand St. to Garberry Block Corp., 45 S. 9th St., at $31,-105; Schenectady Ave. to Greico Bros., 172 Russell St., at $18,291; asphalt paving 65th St., to Brooklyn Alcotraz Asphalt Co., 409 Hamilton Ave., at $41,760.

N. Car., Raleigh—Highway Engrg. & Constr. Co., Shelbyville, Del., awarded contract by State Hwy. Comn. for grading and sand-asphalt paving on 15.48 miles State Project 223, Duplin Co., at $335,-074.

O., Cuyahoga Falls—T. E. McShaffery Co., 173 S. Forge St., Akron, awarded contract for impvt. of 1 mile W. Broad St., 36 ft. Engineer's est., $100,000.

Pa., Harrisburg—State Hwy. Dept. let contract for rein. conc. surfacing 17,530 sq. yds. Rte. 221, Cambria Co., to Fort Pitt Construction Co., Inc., Martin Bldg., Pittsburgh, at $219,915; 8,901 sq. yds. Application 3,177, Tioga Co., to R. D. Richardson Constr. Co., Connell Bldg., Scranton, at $48,989; 53,500 sq. yds. Rte. 241, Wyoming Co., to Rudolph & Delano, Tamaqua, at $287,000.

S. C., Greenville—Henry Construction Co., Emaxcee Bldg., Greenville, awarded contract by State Hwy. Dept. (Columbia) to pave 4.754 miles Greenville-Columbia road, at $131,186.

S. C., Spartanburg—Spartanburg Hwy. Comn. let contr. for 2 sections of roads: 2.25 miles asph. conc., State Hwy. No. 8 from Converse to Cowpens; Southern Paving Co., Union Street, $75,896; 2.792 miles plain conc. State Hwy. 19—Co-operative to Cedar Springs—to Ben H. Martin, Easley, $81,526.

Tenn., Nashville—Dept of Highways and Public Works, Nashville, let contract for 8 roads and 15 St. Hwy. No. 1, and 2 bridges, to W. N. & A. L. Elrod, Murfressboro, at $266,222; Robertson Co. brdg. near Springfield, to Parham Constr. Co., E. St. Louis, Ill., at $10,353; Jackson Co. grade and drain .50 mi. St. Hwy. 3, to H. H. Ruddell, Madisonville, Ky., at $16,695; Meigs Co., 19.03 miles surfacing State Hwy. 58—Decatur and Hamilton Co. line, to T. W. Gwin, Birmingham, at $61,063; Henry Co. 15.17 miles asph. surfacing St. Hwy. No. 43 betw. Paris to Ky. line, Sam E. Finley, 212 W. North Ave., Atlanta, Ga., at $101,766; Harding Co. 7.57 mi. gravel on St. Hwy. 15 to Beardon & Scott, Iuka, Miss., at $128,297; four 20-ft. spans, V. W. Clanton, Tyronza, Ark., at $60,520; Wayne Co. 5.87 mi. gravel on St. Hwy. 15 to T. W. Gwin, at $10,964; 3 brdgs. to V. W. Clanton, at $31,530; Pickett Co. grade and drain 6.05 mi. St. Hwy. 28, also 2 20-ft. spans, to Davis Constr. Co., Wartburg, at $65,063; Carter Co. conc. deck girder brdg. over Laurel Fork near Hampton, C. H. Atkinson & Co., Richmond, Va., at $17,919; Marion Co. 5.16 mi. bitum. macadam St. Hwy. 2 and 20-ft. span brdg. to Carter Constr. Co., care Chattanooga Transfer Co., Chattanooga.

Tex., Alice—Armstrong & Armstrong, Roswell, N. Mexico, awarded contract for grading and bridging 16.1 miles State Hwy. 12, 26 ft. shoulder to shoulder, at $93,389, at $108,550; grading 14.42 miles St. Hwy. 12, 26 ft. to D. H. Buchanan, Temple, at $25,907; bridge on same to Armstrong and Armstrong, Roswell, N. Mexico, at $35,205.

Tex., Carthage—Panola County let contracts for 3 roads: Gravel surfaced rd.—Carters Ferry to Beckville—to Belton Latterman, Nacogdoches, at $59,275; grade, etc., road west from Town to Moore Bros., Lufkin, at $61,400; 6 miles—Carthage to Murvaul—to Tibbetts Constr. Co., 209½ W. 8th St., Fort Worth, at $74,155.

Tex., Carthage—Tibbetts Construction Co., Mineral Wells, award. contract by Panola County to grade and bridge 8.4 miles in Panola County, at $119,557.

Tex., Carrizo Springs—Dimmitt County let contract for 2 roads: Sec. C, grade, bridge and surf. 12.27 miles State Hwy. 85 through Carrizo Springs to Buchanan & Veazy, Temple, at $97,416; Sec. D, grade, bridge and surf. with caliche 11.60 miles State Hwy. 85—Maverick Co. line east to connect with Sec. C, to D. H. Buchanan, Temple, at $102,-146.

Tex., Greenville—Plains Paving Co., Greenville, awarded contract by Hunt Co. for 117,680 sq. yds. Bates section conc. pavement on 11.14 miles State Hwy. No. 1—Concord to Collin Co. line, at $226,413.

Tex., Palestine—N. M. George Constr. Co., Dubach, La., awarded contract by Anderson Co. for grading and surfacing with local material, etc., 10.7 miles Palestine-Tenn. Colony Rd., 16 ft. and 15 miles Palestine-Rusk Road, 16 ft. at $58,483 and $64,787, respectively.

Tex., Sanderson—Smith Bros., American Exchange Bank Bldg., Dallas, awarded contract for about 21 miles conc. surf. on Dixie Hwy.—Van Zandt Co. line through Terrill Co. to Forney—at $600,000.

Tex., Sweetwater—C. O'Neal, Dallas, awarded contract for grading, bitum. surfacing on sledged stone and bridging 12.48 miles State Hwy. 70, at $131,413.

Tex., Vernon—J. P. Foty, Vernon, awarded contract for grading, rein. conc. pavement and bridging 5.26 miles State Hwy. 5, 18 ft., at $157,675.

W. Va., Huntington—Hatfield Construction Co., Deegan-Nobnan Bldg.; J. A. Griffith and Geo. Henkle, 1737 6th Ave., awarded contract by City to grade, curb and pave 14 streets, avenues, alleys, etc., at $104,821.

SEWERAGE AND SEWAGE TREATMENT

Cal., Los Angeles—F. L. Dunagan, 233 W. 88th Pl., awarded contract for sewer in Central Ave.—Florence to Manchester Aves.—at $132,000.

Cal., Tulare—Oakland Sewer Constr. Co., 1003 85th Ave., Oakland, awarded contract by City at $73,780, using vit. pipe and brick manholes for storm and san. sewer system in Tulare.

Cal., Los Angeles—Jno. C. Duncan, 5128 Fairmont Ave., Eagle Rock, awarded contract by South Bay Cities Sanitation Dist. (L. A. County), at $344,970 (using concrete pipe); constr. main trunk sewer line betw. point 10 ft. s. of bound. line betw. Hermosa and Redondo and a point 50 ft. n. e. of P. E. right-of-way, Hyperion; said line within ¼ mi. of ocean with 2 pumping stations (4 pumps). Line will be 28,644 lin. ft. in length and consist of 4,585 ft. 24-in., 3, 323 ft. 27-in. and 15,-730 ft. 30-in. pipe with 82 brick manholes (concrete bases).

Cal., Santa Barbara—United Conc. Pipe Co., Montalvo, will be awarded contract by City for constr. of Garden St. and Quienientos St. trunk sewer, using precast pipe, at $49,460, 354 yds. cradle conc., $7,080 and E. Boulevard interceptor, at $17,-650, in connection with new sewer system; Carreno-Bonilla Co., Santa Barbara, will be award. contr., at $4,890, for Palm Ave., Garden Ave. and Montecita St. sewers—total of two bids, $78,372.

Ont., Hamilton—J. Maguire Constr. Co., 196 Spadina Rd., Toronto, awarded contract for sewers in Burlington Street, 1st sec., at $79,900; 2nd section to Stuart & Sinclair, 17 Jackson St., E., at $27,109; 3rd Sec. to W. L. McFaul, City Hall, at $49,600.

Ont., Toronto—York Twp. will build by Day Labor 6 miles 8-in. and up, vit. tile sewers. Est. cost, $75,000. B. F. Goldike, 40 Jarvis St., Engr. City will construct, by Day Labor, 17,000 ft. rein. concrete and brick trunk sewers in Strachan, Jones

and Pape Aves. Est. cost $435,000. R. C. Harris, City Engr.

Kans., Argentine—W. C. Mullins Constr. Co., 202 Nelson Bldg., Kans. City, awarded contract by Atchison, Topeka & Santa Fe Ry. Co., 406 Delaware St., Topeka, for 5,400 ft. vit. clay sewer pipe, pump house, etc., here, at $143,000.

Kans., Oxford—Burt & Tripp, Hutchinson, award. contract for 28,932 ft. 8 and 10-in. sewers and disposal plant, at $32,183.

Ky., Louisville—Hammen & Co., 4612 Woodward Ave., Detroit, Mich., awarded contract for 4,500 ft. rein. conc. trunk sewer, 6 ft. 5 in. by 9 ft. 7.5 in., in section; also 4,200 ft. tunnel and 300 ft. open cut, at $62,000.

Md., Baltimore—F. Angelozzi, 238 Albemarle St., awarded contr. for sewers in Sewer Dist. H-6-1, Contr. 216, at $32,072; Arundel Co., Knickerbocker Bldg., contract in certain streets and rights-of-way, Sewer Contr. 4, at $10,406.

Mass., Boston—Westinghouse Elec. & Mfg. Co. awarded contr. for electrical equipt. for Nos. 1 and 2 pumping units, Calf Pasture pumping station, at $41,840.

Mich., Royal Oak—R. D. Baker, 1631 Elmhurst Ave., Detroit, award. contract for 14,225 ft. 8-in. vit. sewer in lateral 45, at $49,425.

Mich., Detroit—Dept. Public Works to J. and A. Ponterelli, 400 Penobscot Bldg., for constr. of Lateral 4273, $4,999; Lat. 4274, $800; Lat. 4276, $21,000; J. Monti, 606 Woodward Ave., Lat. 4282, $1,385; Lat. 4286, $1,220; J. Brogan & Sons, Detroit, Lat. 4275, $1,493; J. Diponio Co., 3608 Riopelle St., Lat. 4281, $1,500; G. Leo, 1762 Puritan Ave., Lat. 4283, $4,705; Drainage Constr. Co., Detroit, Lat. 4285, $27,000.

Minn., St. Paul—Feyen Constr. Co., 277 Burgess St., award. contract for sewer at $12,450; Herman Huebscher, 736 E. Hamline Ave., contract for sewer in Otto Ave., at $47,950.

Mo., St. Louis—Bill Hays, Inc., Detroit, Mich., awarded contr. by Board of Public Service, for constr. of water mains from water plant at Howard's Bend to Kings Hwy. Blvd. and Oakland Ave. —approx. 16 miles, at $1,800,494.

N. Y., Brooklyn—P. J. Carlin Constr. Co., Grand Central Terminal, New York City, awarded contract for sewer in Flatlands Ave.—Ralph Ave. to Avenues I and H, and Schenectady Ave. betw. Aves. I and H, at $3,252,124.

N. Y., Long Island City—M. E. Connolly, Pres. Queens Boro, let following contracts: Sewers in Sutter and 79th Aves., etc., to A. Paino, 2016 E. 14th St., Brooklyn, at $148,956; sewer in Moore St. to Green Contracting Co., 734 Vernon Ave., Astoria, at $5,720.

Okla., Okla. City—Koller Plumbing Co., Ponca City, awarded contr. for 47,300 ft. 8 to 15-in. concrete sewers in Capitol Hill and St. Mary's Academy Addn., at $105,415.

Tex., New Braunfels—L. L. Winans, 2127 Heaton Street, Fort Worth, awarded contract for brick and concrete sewage disposal plant, at $26,000; sewerage system to Kirkwood & Wharton, 231 W. Commerce St., San Antonio, at $48,474. Elder & Walker, San Antonio, awarded contract for complete sewage plant, at $72,055.

Tex., Houston—Fleming & Co., Humble Bldg., awarded contract for storm sewer in Rice Blvd., at $31,150.

Va., Richmond—Hughes & Keegan, Real Est. Exch. Bldg., awarded contract for 6,600 ft. 84-in. precast concrete sewer, etc., at $115,559.

Wis., Milwaukee—Bayley Mfg. Co., 732 Greenbush St., awarded contract for forced and inforced draft fan equipt. for filter and dryer house on Jones Island, at $12,853; W. T. Werner, 675 Hi-Mount Blvd., Storm and san sewers in 57th St., at $2,770, 58th St., $1,506, and Mineral St., at $821; G. Zimmerman, 3482 Grand Ave., in 4th Ave., at $7,336; 6th Ave., $12,056; Wenzel & Hancock Co., 498 27th St., in 14th St., at $1,252; 53rd St., etc., at $114,957; J. B. Forrestal Co., 215 15th St., in Pabst Ave., at $119,824.

WATER SUPPLY AND PURIFICATION

Cal., Long Beach—U. S. Cast Iron Pipe Co. will be awarded private contract by City Manager, C. H. Windham, for 10,560 ft. cast iron pipe, at $47,308.80.

Cal., Newport Beach—Claude Fisher, 1682 Fourth St., Santa Monica, awarded contract by City for water distribution and supply system for Corona del Mar, Newport Beach, at $404,885.79.

Ont., Ford City—Essex Border Utilties Comn., Heintzehan Bldg., let contracts as follows: Filtration plant, incl. alum. feed machines, to Canadian International Filter Co., Confederation Life Bldg., Toronto, at $2,050; switchboard equipt. and flow meters to Canadian General Elec. Co., 212 King St., W., Toronto, at $11,271 and $3,260, respectively; traveling cranes to Francis Hankin Co., 386 King St., W., Toronto, $1,548; Venturi meters to Allen General Supplies, Ltd., 205 Yonge St., Toronto, at $5,398; also contract for constr. of tunnel to Merlo, Merlo & Ray, Ford City, at $22,727; steel piping to Horton Steel Co., Bridgeburg, at $10,228; laying 48 in. intake to Considine Reid Co. Ferry Docks, Windsor, at $18,409.

D. C., Washington—Utah Construction Co., Salt Lake City, awarded contract by Secy. Work and Reclamation Commr. Mead for constr. of American Falls dam in Idaho, at $1,281,000.

Ill., La Grange—T. H. Inglehart Co. awarded contract for construction of mains in 31st St., La Grange Park, Cook County; Chas. M. Porter Co. contract for laying water mains in Woodlawn Ave. and other streets, at $136,503.

Ill., Oak Park—W. J. Newman & Co., 21 N. Curtis St., Chicago, awarded contract for 5 m. g. rein. conc. reservoir Lombard Ave. and Lake Street, at $129,000.

Ill., Sesser—E. K. Ladd Constr. Co., Kansas City, Mo., awarded contract for water works and distribution sys. of City, at $225,000.

Ill., Springfield—City awarded contracts for complete iron removal, water softening and filtration plant—this being largest iron removal plant in U. S.: Cope & Fisher, Decatur, Ill., received general contract, at $396,000; E. W. Bacharach & Co., Kansas City, Mo., received filtration contract at $56,900; Dorr Co., New York City, contract for sludge removal equipment, at $15,004; Chicago Bridge & Iron Co. contract for wash water steel tower and tank, at $5,100; total contract price, $473,004.

Ky., Newport—C. T. McFarlan, Kansas City, awarded contract for new filtration plant at reservoirs at St. Thomas, at $109,800.

La., Shreveport—Kaucher-Hodges & Co., Shrine Bldg., Memphis, Tenn., awarded contract for rebuilding and extending filter plant, ft. of McNeil Street, at $115,000.

Md., Baltimore—A. P. Smith Mfg. Co., Norman Street, East Orange, N. J., awarded contract for valves and hydrants for Water Department, at $150,823.

Mass., Boston—Warren Foundry Pipe Co., Phillipsburg, N. J., contract for furnishing 2,300 tons cast iron pipe to Water Dept. here, at $144,055.

Mich., Detroit—M. R. Hanna Co., 1636 Dime Bank Bldg., awarded contract by Bd. of Water Commrs., 176 E. Jefferson Ave., for 30,031 ft. 60-in. 9,566 ft. 46-in. and 8,330 ft. 36 and 42-in. steel mains, etc., at $1,116,545.

N. Y., Brooklyn—Following contracts let by Commr. Water, Supply, Gas & Elec., New York City: N. DeStefano, 257 Glenn Ave., Tompkinsville, awarded contract for mains in Brighton Beach, Mermaid, Neptune, Stillwell and Surf. Avs., Ocean Parkway, etc., etc., at $289,000; mains in Bedford, Hamilton, Highlawn, New Utrecht, Stillwell and 12th Aves., etc., Haring, 65th, 70th, 91st, E. 34th and 94th Sts. here, to Knight & DeMicco, Inc., 448 East Tremont Ave., New York City, at $14,190.

N. Y., Long Island City—S. Gallucci, Railroad Ave., Corona, contr. for mains in Mt. Olivet and Otis Aves., etc., at $6,910, Hylatt, Lewis and Prospect Aves., etc., at $18,000; F. Hanratty, 605 Beach Terrace, New York, at $14,940.

Ohio, Cincinnati—Crumley, Jones & Crumley Co., 2301 Concord St., awarded contract by Hamilton Co., for 46,900 ft. 6 and 8-in. cast iron mains, etc., in Water Supply Line 6, Dist 2, No. College Hill-Steel's Subdiv., and 21,590 ft. 6 and 8-in. cast iron mains in Water Supply Line 3, Dist. 1, Madeira, to Crumley, Jones & Crumley Co., at $91,008 and $41,600, respectively.

O., Cleveland—D. Pfahl, Berea Rd., awarded contract for steel mains in Pearl and Ridge Roads, at $67,748 and $110,693, respectively, also contract to Yaha Bros., 3196 W. 25th Street, for 3,200 ft. 6

to 12-in. cast iron mains in various streets, at $25,756; Joseph Co. Prospect-Fourth Bldg., awarded contract for 7,000 ft. 6 and 8-in. cast iron mains in Impvt. 68, at $34,069.

Tex., San Antonio—San Antonio Water Supply Co., 106 Market St., awarded contracts for 1925 impvts. as follows: Construction of 1,000,000-gal. water reservoir on north side, at $200,000; drilling several wells at Mission Plant on Conception Rd., at $70,000; double capy. of Mission Plant, at $75,000; purchase new pumps, engines, etc.; lay large mains in Southern portion of City, radiating from Mission plant; large feeder main on North Side; lay 2 mi. 20-in. pipe and 2 miles 16-in. and 12-in. pipe.

Wash., Seattle—Felix Aroorace awarded contract for water mains, in 22nd Aves., et al., at $27,737 (de Lavaud pipe); V. Ramaglia, contract for water mains, etc., in W. Nickerson St., at $32,958.

Wash., Wapato—R. A. Geary, Yakima, awarded contract for construction of City's new water system, at $36,693 cast iron constr.)

Wis., Madison—Jno. A. Cullinane, 618 W. Dayton, Madison, contract for force main from Greenbush pump sta. to Nine Springs sewage disp. plant, at $87,000.

Prospective Work

ROADS AND STREETS

Ala., Mobile—City plans street pavement work est. to cost $3,000,000 to $4,000,000. Plans 30 miles conc. road from Mobile to Miss. State line. $450,000. Wright Smith, City Engr.

Ariz., Phoenix—State Engr. W. C. Lefebvre has announced that work is to soon start on paving Tombstone-Bisbee Hwy. Est. cost $119,246.

Cal., Los Angeles—City Engr. H. A. Van Norman has requested City Council for permission to proceed with repair of streets in San Fernando Valley under $1,000,000 repair work fund. San Fernando Rd., Saugus Ave., Lankershim Blvd., and Chatsworth-Zelzah-Devonshire-Canoga Blvd., are among proposed repairs jobs.

Cal., Sacramento—Est. of Div. Engr. J. B. Woodson for direct rte. betw. Fresno and Bishop, through Piute Pass, linking Florence and North Lakes, is betw. a million and one and one-half million dollars. Figures based on 20-ft. rdway. costing from $20,000 to $70,000 per mile. Proj. originated with Fresno Chamber of Commerce.

Cal., Yosemite Nat'l. Pk.—Second deficiency bill of Congress carried appropriation of $1,000,000 for impvt. of roads in National Parks. $350,000 of this sum will be expended in Yosemite National Park.

Fla., Key West—Monroe Co. Commrs. plan to complete road from Key West to Key Large; contemplate $2,000,000 bond issue.

Fla., Miami—City plans to expend $750,000 for street paving; Kentucky rock asphalt, hot mix asphalt, both on rock base. Ernest Cotton, Director of Public Service. F. H. Wharton, City Mgr.

Fla., St. Petersburg—T. J. Upham, Pres., 209 Ninth Ave., N. Shore Acres Properties, Inc., will pave with brick or asphalt block about 1 mile boulevard—Edgewater Basin in Shore Acres to bridge connecting Weedon's Isl. with mainland along shore line of Papy's Bayou.

Fla., Tampa—City plans impvts., including boulevard around lake. Contemplates $3,500,000 bond issue.

Fla., W. Palm Beach—Palm Beach Co. Commrs. plan to build 7 rds. and 2 bridges in Kolsey City Dist. Spcl. Rd. and Brdg. Dist. No. 8; Ocean Blvd. —point east of Kelsey City and Jupiter around head Lake Worth; thence to First Ave. Kelsey City blvd. from Kelsey City to Munyon's Isl. and the ocean; complete county roads from Prosperity School to Kelsey City and from Prosperity school to Dixie Hwy. at Monet; also two 60-ft. draw bridges over navigable channel of Lake Worth at Munyon's Island and Fla. East Coast Canal. $500,000 bonds voted.

Ga., Atlanta—Fulton County Commrs. plan expendt. of $1,000,000 to improve roads; 3 miles North Side Dr.; extend concrete on Bankhead Hwy.—present pavement to Bellwood; grade Wesley Ave. —Piedmont road on east and Moore's Hill Rd. on west; conc. Lawton St. to connect Oakland City with East Pt.; City and Co. Commrs. will grade and pave Madison Ave.—Terminal Sta. to Whitehall St. Virlyn B. Moore, Chrmn. Co. Comn.

Ill., Bloomington—Council passed impvts. as follows: Paving of Emerson St.—viaduct to Center St. and constr. of storm sewer. at est. cost of $131,177.50; concrete pavement on Perrin Ave.—Wash. St. no. to Country Club addn., at $3,742.55

Ill., Rockford—Mayor J. Herman Hallstrom announces street paving program for 1925 totaling $1,000,000. This includes widening of N. Wyman St. and Peach St. from river to Winnebago St. and includes, also stretches of thoroughfares betw. business dist. and city limits.

Ill., Waukegan—Approx. $600,000 worth of paving, water, sewer and sidewalk projects acted upon at recent meeting of Council. Board of Local Impvts. also passed Ord. calling for constr. of sewer, walks, and water mains in practically every street in Krenn & Dato, Webb & Jensen and Warren subdivisions, at est. cost of $270,000.

Iowa, Moville—Plans made. Mature in March. 25 blocks paving. Bids on all types. W. E. Buell & Co., Constr. Engrs., 205 Davidson Bldg., Sioux City. Don Wilkins, City Clk.

La., Lake Charles—Calcasieu Parish and State will build sec. of Old Spanish Trail through marsh to river bank. Est. cost $400,000.

Md., Baltimore—Paving Commission (Samuel A. Rowland, Acting Chmn.) 214 E. Lexington St., plans to expend $950,000 to pave streets in old City; $410,800 for conc. and sheet asphalt on abt. 4 mi. cobblestone streets; $145,000 to grade and pave streets around War Mem. Bldg. and for refunding; $60,000 to pave 15 streets in Homeland; $150,700 for 11 streets; $68,200, City's share to improve 8 streets and $108,600 to pave 14 streets. Howard W. Jackson, Mayor. Stuart Purcell, Chf. Engr.

Minn., St. Paul—Making plans for paving 5th Ave. in New Brighton—6th St. to Minnesota Transfer Ry., Ramsey County. Est. cost $21,000; Wildwood Rd.—E. Co. line to Wildwood—$35,000; paving and grading Prescott connection bet. Prescott brdg. to State Hwy. No. 3, $90,000; paving Payne Ave., State Hwy. No. 1 to N. City limits, $10,000. Paul N. Coates, Co. Engr. 9th Flr. Guardian Life Bldg., St. Paul. Geo. J. Ries, Co. Aud.

Miss., Jackson—Hinds County plans road building, including highway from Jackson to Utica, via Raymond. Contemplates $2,000,000 bond issue.

Miss., Laurel—Jones Co. Bd. of Supvrs. contemplates bldg. 8 miles brick road betw. Laurel and Ellisville. Est. cost $240,000.

Miss., Meridian—$400,000 bonds voted by Lauderdale Co. Bd. of Supvrs. for 4 hard surf. roads: Vimville Rd. to Ala. line, Collinsville to Neshoba line; 5th St. to Newton Co. line; Quitman to Clarke Co. line.

Neb., Loup City—Sherman County will build 12 miles of new rd. to connect with bridge to be constructed across Platte River at Yutan. Donald F. Rowe, Co. Clk.

Nev., Carson City—State Hwy. Department is preparing plans on following projects: 2.60 miles grading, Washoe County; Sparts to Vista. 16.00 mi. grading, Washoe County—Hafed to Denby. 12.3 miles gravel surf. Eureka County—Shoshone Point to 12 miles east. 12 miles E. Shoshone Pt. to E. County line, Eureka Co., 10.1 mi. gravel surf., 7 miles gravel surf., Conners Pass to So. County line, White Pine Co. Surveys recently completed on following: Paradise Summit to McDermitt, Humboldt Co., Mineral Co. Lyon Co. line to Schurz; Nye Co., across Tonopah Twp.; Douglas Co., 5 miles west of Wellington to nr. Carters Sta.; Eureka Co., Hay Ranch to W. Co. line and Dunphy to Elko Co. line via Emigrant Pass; Douglass Co., East Co. line to 5 miles west. Geo. W. Borden, State Hwy. Engr.

N. C., Wilson—Wilson Co. Commrs. plan to improve public hwys. Probably call election to vote on $1,250,000 bonds.

N. Dak., Bismarck—Counties in State have requested State Hwy. Commission for road work totaling 490 miles earth grading, 278.85 miles gravel surf., .75 miles paving.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Kentucky Rock Asphalt Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Chausse Oil Burner Co.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Chausse Oil Burner Co.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Chausse Oil Burner Co.
Littleford Brothers.

Auto Fire Apparatus.
Kissel Motor Car Co.
International Motor Co.
Pierce-Arrow Motor Car Co.

Automobiles.
Ford Motor Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Brick, Paving.
National Paving Brick Mfrs. Assn.

Bridges.
Luten, Daniel B.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping
Littleford Brothers.
Pawling & Harnischfeger

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Gun Work.
Indiana Gunite & Const. Co.

Cement Testing.
Chicago Paving Laboratory.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chemists, Engineering
Chicago Paving Laboratory.
Dow & Smith.
Flood & Co., Walter H.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Van Trump, Isaac.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Clay Pipe, Vitrified.
Clay Products Assn.

Clay Products.
Clay Products Assn.

Concrete Bridges.
Luten, Daniel B.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Rosing, Inc., Astrid S.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Consulting Engineers.
Alvord, Burdick & Howson.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Druar & Milinowski.
Flood, Walter H., & Co.
Howard, J. W.
Hunt Co., Robert W.
Indianapolis Paving Laboratory.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Okla., Pauls Valley—Garvin County plans bldg. hard surf. road from north line County through town and Wynnewood to Murray Co. hard surf. road. $720,000 bonds voted.

Ore., Astoria—New policy with regard to Nehalem Hwy., Clatsop County, adopted. All available funds (abt. $160,000 for 1923, will be expended for pushing grade or road an additional 5 miles, or to summit betw. Klastkanine and Nehalem river basins.

S. Car., Clinton—City plans street paving. $160,000 bonds voted. J. Newton Johnston, City Engr.

Tenn., Mephis—City plans street paving and street impvts. Proposes $400,000 bond issue. Rowlette Paine, Mayor.

Tenn., Somerville—Fayette Co. Court plans bldg. Muscle Shoals Hwy.—Shelby Co. line to Hardeman Co. line. $100,000 bond issue contemplated.

Tex., Anson—Jones County plans 44 miles of Stanford-Albany road from Shackleford through Jones and Haskell Cos. Est. cost $910,800; first sec., including 20-ft. span bridge, to cost $365,100. J .W. Puckett, County Engr.

Tex., Corsicana—Navarro County Good Roads Assn., organized with Judge C. L. ester, Chrmn. Tommy Farmer, Secy., plans bldg. roads in County. Considering $6,000,000 bond issue.

Tex., Waco—City Commission plans additional street paving; considering $250,000 bond issue.

Va., Fairfax—State Highway Commission, Richmond, has appropriated $249,000 to complete 9 miles Lee Hwy.—Fairfax Court House to point beyond Centerville near Manassas battlefields.

Va., Ft. Myer Hts.—Arlington District, Good Roads Comn., plans to expend $749,510 for constr. of 20 miles of rds. Bond election planned.

Wash., Olympia—Following road work will be let for impvt. during 1925: Des Moines-Kent Rd., $85,000; 16th Ave. SW-Lake Burien Rd., $76,656; Auburn So. Road (including brdg. over Stuck River), $100,000; Greenwood Ave. widening, $71,786; 85th—No. Trunk Rd. to 15th Ave., N.W., $50,000; 10th Ave., N.E. extension, $37,500—total $420,942. Rd. and Bridge Fund—$226,622; Road Dist. Fund, $102,890.

W. Va., Huntington—Cabell Co. plans road bldg.; contemplates $20,000,000 bond issue.

W. Va., Parkersburg—City plans paving 25 or 30 streets and laying long sewer in Dist east of City Park. Will vote in Feb. on $500,000 bonds. J. S. Dunn, Mayor.

Wis., Madison—Various counties in State have appropriated $5,917,684 for street and road work during 1925.

Wis., Monroe—Co. Bd. appropriated $214,998 for county and state hwy. construction. C. J. Smith, Commr.

SEWERAGE AND SEWAGE TREATMENT

Cal., Brea—$60,000 sewer bond issue carried at recent election. F. S. Currie, Cons. Engr.

Cal., Burbank—Second unit of sewer system, providing laterals for practically all territory above Third St., ordered by City Trustees. This system will cover 96 blocks betw. Alameda and Walnut Aves. and 3rd and 11th Sts. and will involve 8-10 inch vit. pipe, manholes, wyes, 6-in. hse. sewers, etc. A. J. Rose, City Engr. F. S. Webster, City Clk.

Cal., Long Beach—City has adopted plans and specfs. for new drainage system on 21st St. and Hill St.—Pasadena to Oregon Aves. $81,000. R. D. Van Alstine, City Engr.

Cal., Long Beach—City's share of county san. plan, bonds for which are to be voted in Feb. and Mch. (Long Beach date, March 3rd) is $3,540,000.

Cal., Los Angeles—Bids will be asked by Board of Public Works soon for constr. of Arroyo de la Sacatella storm drain planned to serve the West Pico, Wilshire and Hollywood districts, about 16 sq. miles. Est. to cost betw. $2,500,000 and $4,000,000.

Cal., Riverside—Mayor S. C. Evans announces that bond issue for water impvts. is under consideration. Proposed plans include 10 mile 42-in. pipe line for main supply, large storage reservoir on East Side and replacement of small water mains throughout City.

Cal., Santa Barbara—City Engr. Geo. D. Morrison announced that plans for 4 sewer systems, totaling $350,000 (initial outlay), are under way.

Ont., Toronto—Plans being made for 8-in. vit. tile, conc. and brick trunk interceptor sewers in northern section, covering about 6 square miles. Est. cost $10,000,000. R. C. Harris, City Engr.

B. C., Vancouver—$200,000 bonds voted for sewers in various streets. C. Brackenridge, City Engr.

Fla., Miami—City plans expendt. of $750,000 for sewers. Ernest Cotton, Director of Public Works. F. H. Wharton, Mgr.

Ga., Atlanta—Clarke Donaldson, Asst. Chf. of Sewer Constr. has recommended expendt. of $441,222 for sewer constr. in 1925.

Ill., East St. Louis—Plans sewers in various streets. Est. cost $750,000. W. McK. Brown, City Hall, Engr.

Ill., Highland—Town considering constr. of 6 to 16 inch san. sewers; 2 set pc. tanks, etc. Est. cost abt. $75,000. C. E. Wilson, Engr., Marion; L. Day, 34 E. Grand Ave., St. Louis, Mo., Cons. Engr.

Ill., Quincy—Soon to receive bids for san. sewers for Jefferson St. Sewer Dist., $90,000. W. F. Bushnell, City Hall Engr.

Ia., Des Moines—Contemplate expendt. of $200,000 for Urbandale sewer and $50,000 for storm sewer in 33rd St. A. E. McGlothlen, City Clk.

Ky., Louisville—Commrs. Sewerage have approved expenditure of $5,000,000 for sewers.

Mass., Lynn—City plans outfall sewer line to 3 miles beyond present outfall on Lynn Harbor. $1,500,000.

Minn., Rochester—Plans being made for sewage disposal plant. Frederic Bass, 516 SE. 6th St., Minneapolis. Will use either Imhoff tank and percolating filter or activated sludge types. About $275,000. A. F. Wright, City Clk.

N. J., Margate—City considering extension of sewer and water systems at cost of about $100,000. Engineer not yet selected. J. Risley, Mayor.

N. C., Greensboro—City will probably begin construction of storm sewer system in the spring. Contour map being made of city by engineers. Est. cost $500,000.

Ohio, Akron—City plans second section of Hakkins Ave. intercepting sewer; $300,000, and Sec. 5 of Mellon Run trunk sewer, $150,000. W. F. Peters, Service Director.

Ohio, Cleveland—City making plans for sewage disposal plant, screen bldgs., pump house, office, venturi house, pumping bldg. and disposing tanks; 100,00 c. y. earth excav., etc., $3,500,000. G. B. Gascoigne, 648 Leader-News Bldg., Cons. Engrs.

Okla., Oklahoma City—Election April 7 to vote on $1,900,000 bonds for 4 miles outfall sewers and disposal plant. B. M. Hart, City Hall Engr.

Tenn., Memphis—City considering issuance of $337,000 bonds for sewer construction. Rowlett Paine, Mayor.

Tex., Houston—City (F. O. Holcombe, Mayor) votes April 13 on $500,000 water works bonds.

Tex., San Angelo—Election soon to vote on $200,000 bonds for sewage disposal plant. E. I. Jackson, Mayor. Engr. not yet selected.

Tex., San Saba—Prelim. plans being made for sewerage system, disposal plant and main extensions in various streets. Est. cost $70,000. Terrell, Bartlett, Engrs., 612 Calcasieu Bldg., San Antonio.

Wis., Milwaukee—City has included $2,000,000 bonds for sewers in 1925 budget.

WATER SUPPLY AND PURIFICATION

Ariz., Flagstaff—$475,000 bonds voted for water works. Plans under way for 18 miles gravity flow line; $50,000,000 gal. concrete reservoir and 5 miles pipe distribution system. Bids will be asked early in March. Burns & McDonnell Engrg. Co., Cons. Engrs.

Cal., Los Banos—A. J. Wiley, Cons. Engr. for San Joaquin River Water Storage Dist. has est. cost of 100,000 ac. ft. dam at approx. $4,585,000 and a 600,000 ft. dam at $18,000,000.

Cal., Santa Barbara—City plans to purchase new services, meters and mains for water improvements. Est. cost $235,000. H. Nunn, City Mgr.

B. C., Nelson—A. L. McCulloch, Hydraulic Engr., submitted report to Council recommending that water supply be taken from Five Mile Crk. at approx. cost of $115,000. Pipe will be required to extent of 4.7.

Ont., Toronto—$14,000,000 bonds voted here for water works system in eastern section of city.

BUYERS' GUIDE

Deep Well Pumps.
Harris Air Pump Co.
Keystone Driller Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Dryers.
Cummer & Son, The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Machinery.
Westinghouse Electric & Mfg. Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Excavating Machinery.
Austin Machinery Corp.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co., Inc.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Gates, Sluice.
Coldwell-Wilcox Co.

Graders.
Austin-Western Road Machinery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gunite.
Indiana Gunite & Const. Co.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

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Austin-Western Road Machinery Co.
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Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Fla., Manatee—$90,000 bonds voted for constr. of water works; $20,000 bonds for addn. to san. sewers; $17,000 for impvt. and alteration of open drains; $15,000 for constr. of storm sewers.

Ga., Cordele—City (C. D. Terrell, Mgr.) will vote on $120,000 bonds for bldg. power and distributing system and draining system.

Ill., Sesser—Specfs. drawn for water works sys. and have been incorporated in Ord., unanimously adopted. Specifs. call for filter plant and storage tank of 5,000 gals. capy., in connection with which there will be an impounding reservoir of some 120,000 gals. capy. A. C. Lewis, Atty. in charge of legal end of impvt.

Ill., Wood River—Resolution passed by Council providing for exten. of water mains in Hartnett Terrace Add. Est. cost $72,132.

Ind., Indianapolis—Indianapolis Water Co. contemplates expendt. of approx. $1,500,000 on impvts. during 1925. C. E. Davis, Mgr. Impvts. will include new mains, impvt. of Fall Creek filtration plant and meters (probably purch. 10,000 meters.)

Md., Baltimore—Mayor and City Council making plans for 20-in. main in Gwynn Falls Parkway—Tioga to Liberty Hts. to Poplar Grove St. and Beech Ave., at cost $175,000; 36-in. second zone feeder main in Mondawnin Ave. Ave. exten. from Reistertown Rd. to Gwynn Falls Pkway, $200,000; 16-in. main in Cook's Lane—21-in. main in Forest Ave. to Edmondson Ave., $175,000; 36-in. feeder main in North Ave., Broadway to Gay St., $200,000. V. B. Siems, City Hall, Water Engr.

Md., Salisbury—Abel Welman, Chf. Engr. State Board of Health, 16 W. Saratoga St., Baltimore, making survey of city, preparatory to installing water system. $500,000 available.

Miss., Jackson—Ctiy having estimates prepared for water exten. to water and sewer, $300,000.

Miss., Lucedale—City contemplates voting on $200,000 bonds for water and sewers.

Mo., Fredericktown—City making plans for new water works. $112,000 bonds voted. C. A. Haskins, 517 Finance Bldg., Kansas City, Engr.

Mo., Salem—$90,000 voted for water works and sewer constr. City has retained Engr. Fred J. Wagner to supervise the $1,500,000 project to bring Florence Creek soft water into city. Plans under way and bids for labor and materials will soon be asked.

N. C., Winston-Salem—City Pub. Wks. Dept. has outlined plans for impvts. during 1925, including therein $400,000 for sewage disposal plant; $600,000 for water works filtration plant, aerator, force mains, etc.

Ohio, Cleveland—Bids will be advertised for this spring for 11,000 ft. 24-in. steel or cast iron main in Clifton Blvd., Warren Rd. to Rocky River; $157,000; 7,980 ft. 36-in. steel or cast iron main in Ridge Rd.-Memphis Ave. to Brook Park, Sec. 4, $170,000. Engr., City Hall, A. V. Ruggles.

Ohio, Painesville—City plans new filters, 1 m. g. capy., centrif. pumps and concrete filter beds. Est. cost $125,000. Hadlow, Hick & Co., Finance Bldg., Cons. Engrs., Cleveland.

Okla., Enid—Surveys being made for additional water supply; cost of impvt. est. at $1,500,000. Black & Veatch, Mutual Bldg., Kansas City., Mo., Contrs.

Okla., Okmulgee—Surveys and plans under way for 15 miles 24 in. pipe line, receiving reservoir, extensions to distribution system and other impvts. Est. cost $1,500,000. Burns & McDonnell Engrg. Co., Cons. Engrs.

Ore., Ashland—In detailed report Engr. McKissick outlined only feasible plan to increase water supply of city. Engr. advises tapping, by means of pipe line and tunnel, several tributaries of Cow Crk., a tributary of east fork of the California Beaver Crk. Water can be secured by constructing 11½ miles pipe line and a $3,800-ft. tunnel.

Ore., Eugene—Stevens & Koon, Cons. Engrs., Spalding Bldg., Portland, retained to advise city on extension and impvt. of water system. Plans already considered in Eugene call for considerable changes upon which the Portland firm has been requested to pass. One of chief features of new plan will be pipe line about 5 miles long.

S. C., Florence—City may vote on approx. 350,000 bonds for constr. of water works plant on Black Crk.; laying of pipe and ext. of water wks.

S. C., Landrum—City has retained Spoon & Lewis, Cons. Engrs., Greensboro, N. C., to prepare plans and to supervise constr. of water and sewerage systems. $100,000 available.

Tenn., Knoxville—Prelim. plans and surveys of Holston and Tenn. Rivers being made for location of new intakes, filtration plant and pumping station. Est. cost of impvts. $2,500,000. F. A. Albert, Supt. of Water Wks.

Tex., Amarillo—City will vote April 7th on $1,750,000 water bonds. Eugene Blasdel, Mayor.

Tex., Comanche—$120,000 bonds voted here for water and gas. J. R. Eanes, Mayor.

Tex., San Antonio—City will plan and supervise constr. of Olnos Creek Detention dam; gravity type; 80 ft. high, 2,000 ft. long. Est. cost $2,200,000. Plans will probably be ready about April. S. F. Crecelius, Flood Protection Engr., 304 City Hall, will have charge of the work.

Wash., Olympia—Grays Harbor Ry. & Light Co., Aberdeen, has applied to Marvin Chase, State Supvr. of Hydrs., for water right on Hoh River, Clallam Co., for purpose of bldg. reservoir, constr. of which will cost abt. $3,000,000. Reservoir is in connection with proposed hydro-elec. plant to be built by company. It would store 97,000 acres each.

Wis., Milwaukee—Milwaukee will lay 54-in. pressure main in the Burleigh St. section of city. Est. cost of line $300,000. Work will be started in the spring and expected to be finished during summer.

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Dee Clay Mfg. Co., W. E.
Rosing, Inc., Astrid S.

Sewer Pipe Joint Compound.
The Barrett Co.

Sewer Rods.
Stewart, W. H.

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Coldwell-Wilcox Co.

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Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

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Lufkin Rule Co., The

Sweepers.
Austin-Western Road Machinery Co., The

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The Barrett Co.

Tarvia.
The Barrett Co.

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Van Trump, Isaac.

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Austin-Western Road Mach. Co.

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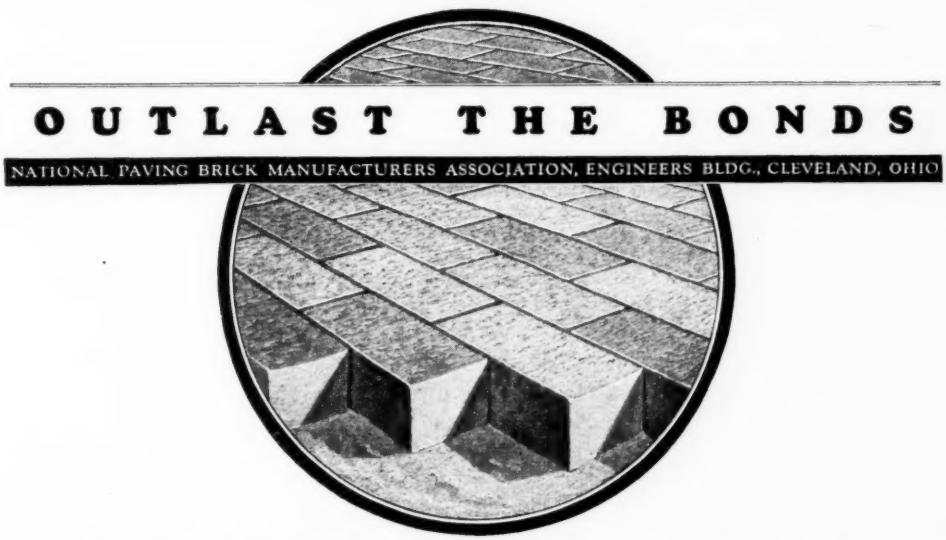

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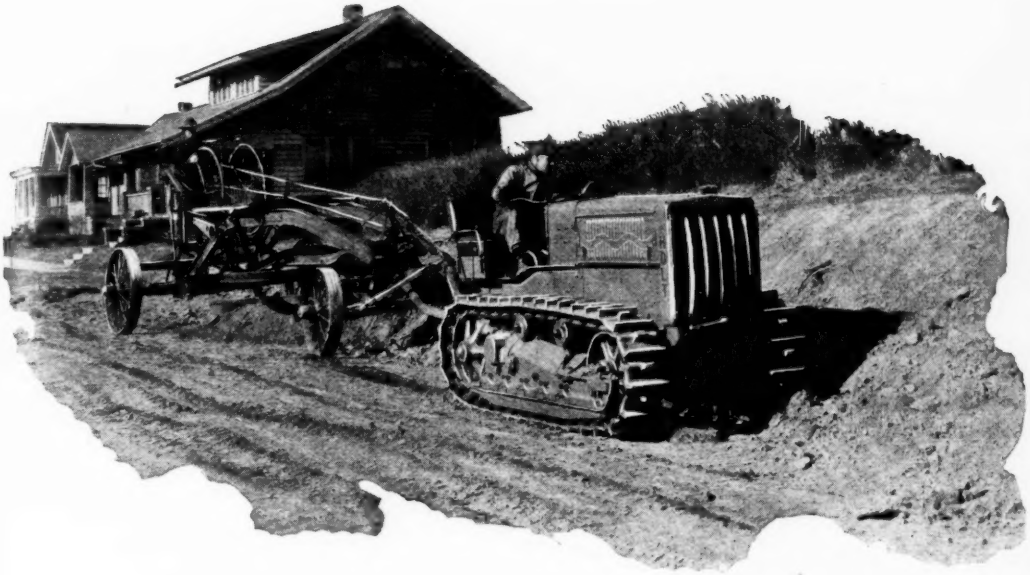

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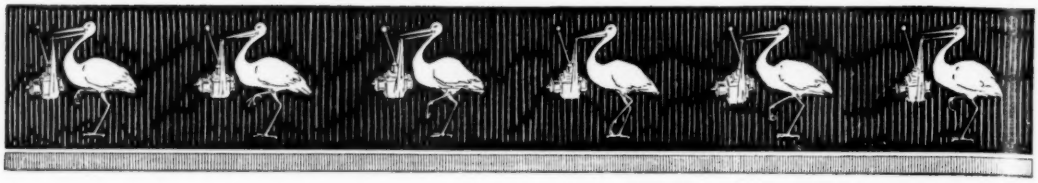

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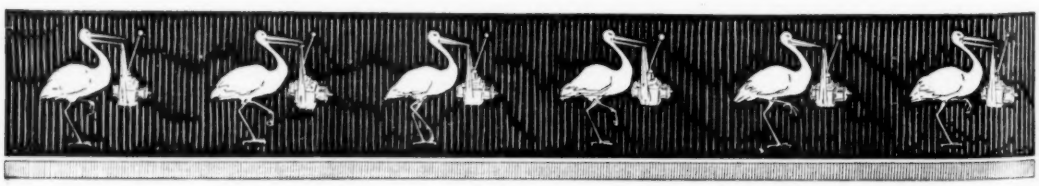

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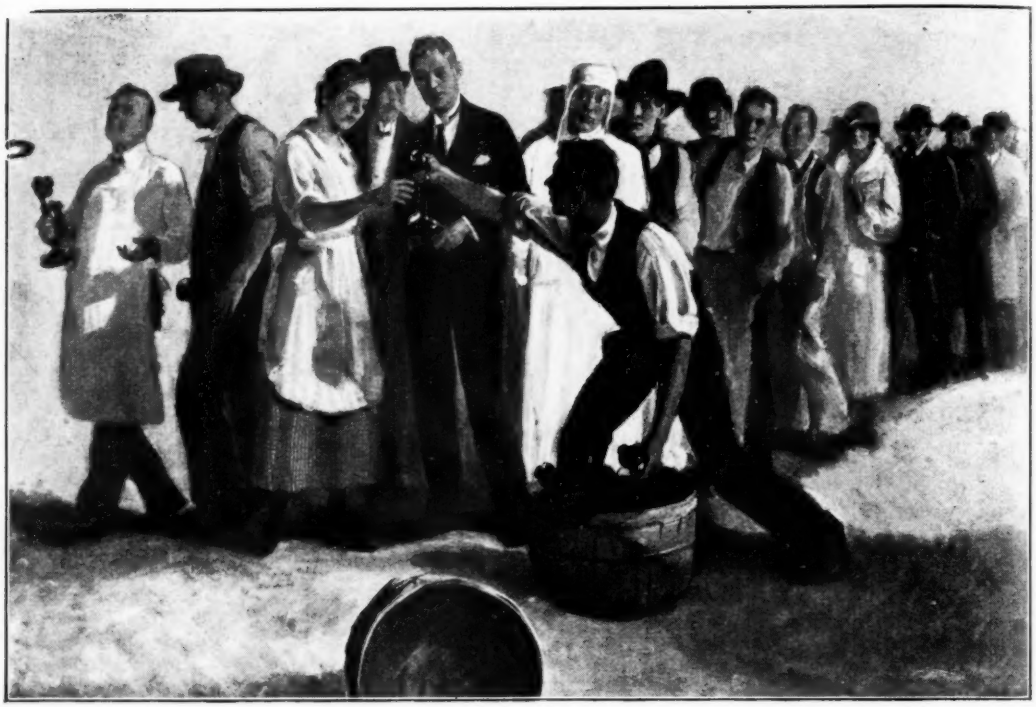

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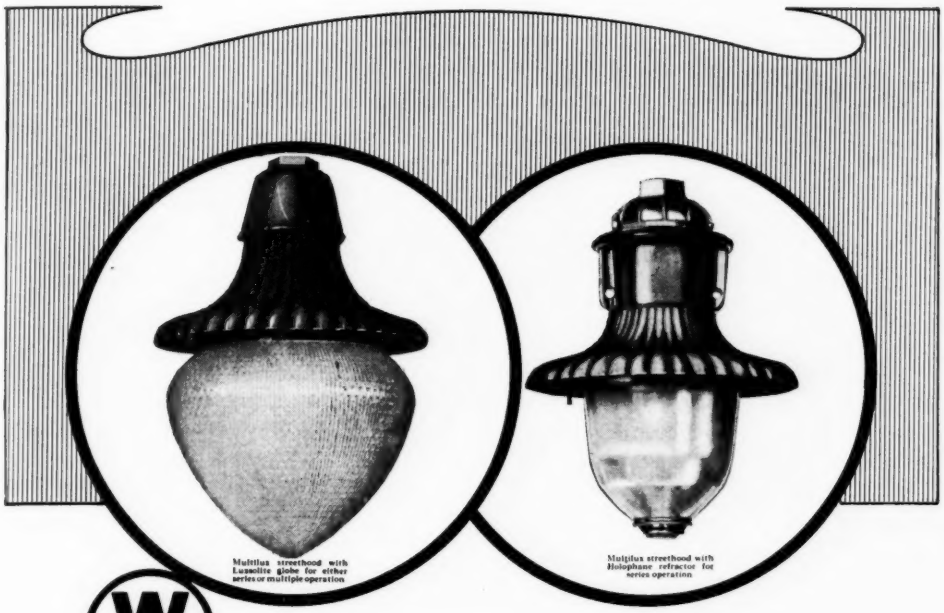
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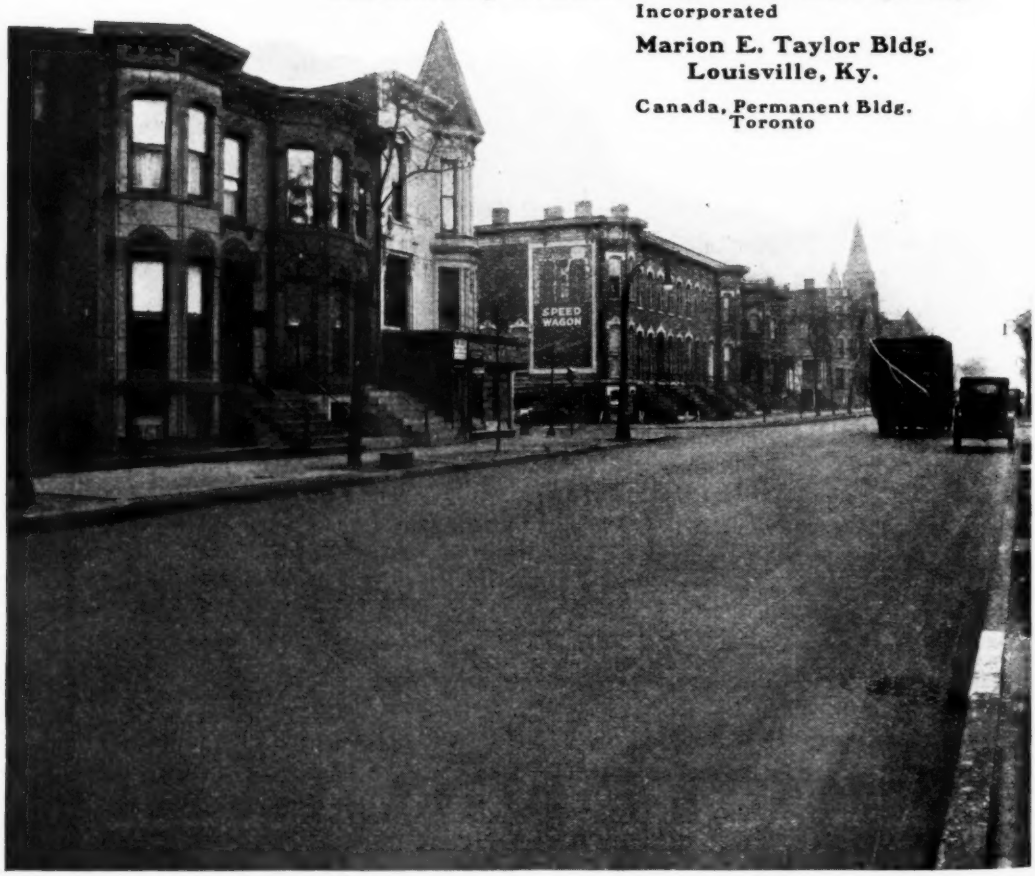

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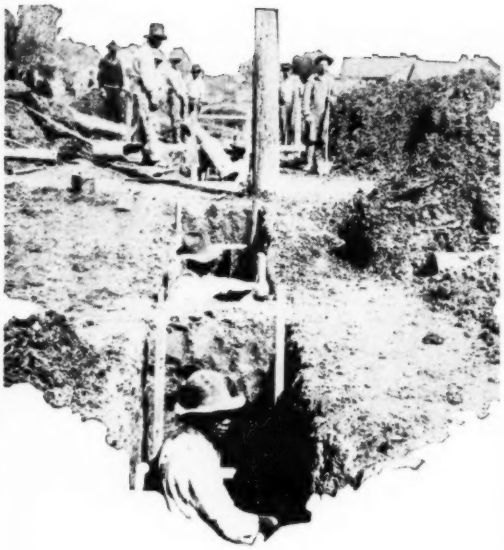

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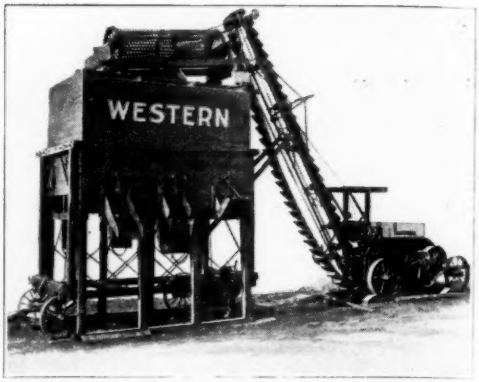

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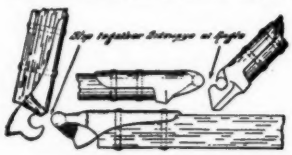

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RELATION OF FORM SETTING TO RIDING QUALITIES OF CONCRETE PAVEMENTS

By C. N. Conner, State Construction Engineer, North Carolina State Highway Commission, Raleigh, N. C.

The problem confronting highway departments and road contractors who take pride in their work and are determined to give the taxpayer a road that is straight, true and smooth, has been solvable only in one way—use of a reliable steel side form that will stay true and smooth throughout the construction of the road. The form must be light enough to be handled economically and strong enough to stand maximum abuse.

A no less authority than Mr. A. T. Goldbeck of the Bureau of Public Roads, states that: "Uneveness of side forms is an inexcusable defect and results in an uneven surface."

Increased truck hauling with the fearful impacts developed through the use of first solid tires has made necessary the rigid requirements of State Highway Departments for an absolutely smooth road.

Careful investigation on the part of the United States Bureau of Roads, relative to road surface, has shown conclusively that it is not the dead weight of motor trucks that destroys the highways. If a full truck strikes an obstruction in the road, or if the road surface is uneven, the wheel comes down on the road with a thud at every wave or break in the surface. It is this impact that does the destroying, crushing the surface and finally breaking the foundation. A smooth road will eliminate a very large percentage of this impact.

Road Forms an Important Factor

Road building forms are a very important factor in the contractor's equipment and should be selected with utmost care because the smooth, even finished surface required depends almost entirely upon the road rail used.

The day when the road contractors could afford to worry along with wooden forms has passed. High labor and lumber costs, the rapidly increasing demand for greater yardage per day, have been important factors in sending lumber forms to the scrap heap. But, of equal importance has been the fact that good roadbuilding can't be done with lumber forms, which slide and bend, wasting time and material, and making true grading an impossibility.

Following the lumber forms came a flood of incorrectly designed, poorly built metal rails—flimsy, too complicated for ordinary laborers to handle with any speed, and with most of the faults which put wooden forms on the retired list. Rails that wouldn't stand up against the pressure of the heavy concrete fill; rails that buckled under the weight of the sub-grader and finishing machine; rails with loose parts that are constantly being lost. Rails that caught and held concrete.

I have known of more than one road built with wood forms which cost $2.50 or more per sq. yd. for good concrete, whose riding surface is rough and whose life is impaired by impact resulting from this roughness. The difference in cost between the wood forms and steel forms would not have amounted to more than 1 cent per sq. yd.

Forms for highway construction have not been given the consideration this class of equipment should receive. Only in recent years have some highway departments taken the form equipment question seriously. They are, however, beginning to appreciate that form equipment plays an important part, just as does the concrete mixer.

Contractors are being educated by some highway departments to keep their form equipment in proper condition and up to the requirements, which are in no instance unreasonable. The aggregates may be properly proportioned, mixed, placed, and finished, but, if the forms are not to line and grade, an unsightly job is the result with the road surface uneven.

Among the first steel forms used, were some designed as the "Hanging System of Steel Forms." This system comprised steel angle iron stakes made of 1 1-2x1-4 in. steel angle, with a slotted plate riveted to the top. The stake was driven to line and grade and the road rails made of 12 gauge steel with 2 in. top flange and 2 in. bottom flange hung on tov of the stake in a suspended position. The only bearing that this form had was that of the stakes as produced by the friction of the subgrade where they were driven into the ground.

This type of form was found to be easily set, as it eliminated the necessity of preparing the base to accomodate the forms. All that was necessary was to drive the stake to the line and grade and suspend the rail in position.

It was found, however, that it was almost impossible to produce a road free of depressions and waves with this type of form, for the reason that after the forms were set perfectly to line and grade, the stakes would gradually work into the ground by the manipulation of the hand tap. Even in some cases, the manipulation of the heavy screed caused the stakes to depress and sink into the subgrade, which naturally produced waves in the road. Therefore, back as early as 1914 it was discovered that it was necessary for the base of the rail to have a bearing on the sub-grade substantially the full length of the rail.

The wood forms and early types of steel forms did very well because the people were so well pleased with a hard surface road to ride upon that they did not mind the ugliness.

It was not long before engineers decided that country roads could be built as smooth as city streets. Finishing machines and new methods of hand finish were devised and the form people co-operated in putting out better and more substantial steel forms. They were a little slow at first to see the light, but when they did clearly understand the need there was no lack of effort to furnish forms to meet the most rigid specifications and to carry the heaviest finishing machine.

It may not be known that officials of several form companies give credit to Mr. Chas. M. Upham for being the first highway engineer to insist on heavy and substantial forms.

Conflicting Specifications

Unfortunately at the present time there is a wide divergence in the specifications of several of the states; some are very lax while others are very rigid.

In some instances the weight of forms is specified; in other instances, weight per foot; others specify the width of base, number of stakes to the rail, and complete details.

In the majority of states wood or steel forms are optional and with some variance as to weight (of steel) or thickness (of wood).

Three states specify wood forms with no reference to steel forms (Nevada, Minnesota and Washington). It is the practice in Washington to leave the wood form or ribbon in place.

Four states definitely prohibit the use of wood forms (Delaware, Maine, Maryland and Virginia).

Fifteen states in addition to the four previously mentioned specify steel forms (Conn., Georgia, Illinois, Indiana, Michigan, Missouri, Nebraska, New Jersey, New Mexico, North Carolina, New York, Ohio, Pennsylvania, Rhode Island and Vermont.) Of these, four mention that wood forms be allowed on curves (New York, Penn., Conn., and North Carolina). The last two specify on curves of less than 150 ft. radius.

Weight of Steel Forms

Weight is named in specifications of eight states. Pounds per foot—Delaware, 8; Indiana, 9; Michigan, 10; New Jersey, 7; New York, 6½; North Carolina, 7 to 10; Pennsylvania, 8 to 9; Virginia, 8. It is assumed that in other states this question is left to the engineer.

Thickness of Wood Forms

A minimum of 2 ins. is allowed in 20 states.

A minimum of 2¾ ins. is allowed in 1 state.

A minimum of 3 ins. is allowed in 4 states.

The following is an extract from the specifications of our state, which represents average good practice but still can be improved upon.

North Carolina Specifications

Outside forms for this work shall be of metal, of the depth of the concrete, with no horizontal joints, and shall be straight, free from warp, and of sufficient strength, when staked, to resist the pressure of the concrete and finishing machine or finishing tools without springing or settlement. The width of the forms at their base shall be such that the maximum load under any method of finishing shall not be more than 7 lbs. per sq. in. on the subgrade. In the event the subgrade is unusually soft the use of finishing machine may be discontinued, and the standard hand finish be substituted. Only approved steel forms shall be used, weighing not less than 7 lbs. per lin. ft. for 5-in. forms, and not less than 8 lbs. per lin. ft. for 6-in. forms and not less than 9 lbs. per lin. ft. for 7-in. forms, and not less than 10 lbs. per lin. ft. for 8-in. forms, and not less than 11 lbs. per lin. ft. for 9-in. forms, exclusive of wedges and pins. The use of wood or steel blocks to secure the required depth of section shall not be permitted. On all projects exceeding three miles in length new metal forms of approved type shall be furnished. Forms that become bent or deformed shall be condemned and immediately removed from the work until sat-

isfactorily repaired and straightened. These forms shall be inspected and accepted by the engineer before being returned to the work. Finished sub-grade shall be prepared and forms shall at all times be set and kept true to line and grade at least 200 ft. in advance of the mixer. Whenever the sub-grade is not capable of bearing the weight of forms, finishing machine or finishing tools without settlement, the engineer may require suitable stakes driven to the grade of the bottom of the forms, sufficient in number to give the necessary support. The engineer may, however, require additional bearing area under the forms by securely fastening them to planks secured to the sub-grade by the required number of pins. The planks shall be of such width and so fastened that no settlement or displacements occur. The alignment and grade of all forms shall be approved before and immediately prior to the placing of concrete against them. The entire length of the form shall be set directly in contact with the finished sub-grade which shall be compacted by rolling for at least 12 ins. on each side of roadway outside the area required for the road metal to rest upon. The building of pedestals of earth or other material upon which to rest the forms in order to bring them up to the required grade will not be permitted. For curves of radius less than 150 ft., wooden side forms 2 ins. in width and of the depth of the concrete, of well seasoned surfaced planks may be used with written permission from the engineer. The length and number of pins shall be increased if necessary to maintain the forms to correct line and grade, but in no case shall less than three be used to each 10 ft. section.

Sufficient forms shall be provided, so that it will not be necessary to remove them in less than 12 hrs. after concrete has been placed, or longer if required. Forms shall be cleaned and oiled before concrete is placed.

Road slabs have been built as light as 4 ins. thick. Steel forms have been made as light as No. 12 gauge. Today road slabs are built as thick as 12 ins., with steel forms ¼-in. thick.

A road rail could be made of steel 1/16-in. thick, and atttachments added to it to bring its weight up to the requirements of weight per foot. Such a form while meeting the specifications as to weight per foot, would not give the service, would not stand the rough handling, and would be reduced to scrap heap in short order, leaving a poorly built road behind.

Therefore, specifications regulating weight of forms per foot are important. The thickness of steel used should be specified, as well as the base of the form, number of stake pockets, length of the rail sections and width of tread flange.

Steel road forms should not in general be made of steel lighter than 3/16-in., regardless of the shape of the rail section. A rail made of material lighter than 3/16-in. will not give as good service and will not survive the rough treatment in use and in handling on the average road job where heavy finishing machines and sub-grades are used, and the man with the 10-lb. sledge is ever present.

Delivery of materials by truck has brought on a new hazard in that the trucks back over the forms or collide with them in turning on the sub-grade, requiring the forms to be well staked at the joints and midway between the joints.

Dimensions of Forms

At the present time several manufacturers have standardized on 3/16-in. forms and there is a possibility that 1.4-in. steel may soon be used in the manufacture of road forms of great depth, say 12 ins. and deeper.

The length of form at the present time is fairly well standardized on 10 ft. for tangents and the majority of curves. Shorter lengths for sharper curvature are available from most companies.

One company has standardized on a 12-ft. length with a view of reducing the number of joints, and the consequent possibility of an inequality in the pavement opposite the joints.

The height of forms should, of course, be equal to the required depth of the pavement at its edge. It is, of course, possible to use a form of greater depth but extra labor is generally required to get the base down to grade and the contractors run the risk of laying too great a depth of pavement.

If the forms are not of sufficient depth it is possible to support them on planks or metal but again extra labor is involved and the added weight makes handling difficult. The result is that most engineers require full depth forms.

The base width of a form should be sufficient to carry the weight of all tools or machines, including impact to the sub-grade without settlement. Some newly prepared or moist sub-grades will not support without settlement more than 1,000 lbs. per sq. ft. By knowing the

weight of a machine, one can readily calculate what load per square inch reaches the sub-grade.

Particularly after the power machine came into existence, it was extremely necessary that a solid bearing be secured all along the rail, so as to eliminate the possibility of any depression on account of the tamping act of the finishing machine weighing several tons.

To eliminate all possibility of depressions the base flange of the road rails was increased from 2 to 3 ins.; later from 4 to 6 ins. wide. Some highway depart- at present time modern road forms generally used have a base flange of from 3 to 4 ins. and later 4 to 6 ins., so that ments stipulate that the side forms must be firmly imbedded on the subgrade, so as to eliminate any possibility of depression. It has been determined by many engineers that the only way to guard against possibility of depressions or waves in the road surface, is to take care of this in the steel forms design by eliminating the possibility of suspending a rail above the sub-grade, and compel the setting of the forms firmly on the sub-grade.

Base flanges are now not less than 4 ins. wide, and a 6-in. base for extremely sandy or loamy sub-grades.

The top flange is not less than 1½ ins. or more than 2½ ins. wide, preferably 2 ins. wide, according to most specifications.

The width on the top of most forms now on the market is about 2 ins. This, I believe, is unnecessary and perhaps dangerous. To my mind the top width should only be sufficient to carry the finishing machinery or tools, but the depth of the top should be ample to develop the web strength.

A desirable steel road form must be designed so that it is not only straight and true, but also able to withstand the rough handling to which such a piece of apparatus is subject.

Joints

Joints in the forms should be so designed to connect the abutting ends of the rails neatly and securely, so there will be no sagging. Stakes should be inserted as close as possible to the rail joint.

Regardless of the strength of the form itself, if the connecting device is weak, the entire system cannot be depended upon.

We often see pictures of men standing on a form point or a great mass of pig iron piled on the joint, but to my mind neither of these are a test nor do they even approximate the loads or stresses to which forms are often subjected in the field.

A hard blow from a 10 or 16-lb. sledge will do more damage than the weight of 10 or 16 men—the weight of a finishing machine, bouncing over a ¼-in. stone is just as bad, especially at a joint; a hard wallop from a truck wheel or a subgrader will put a form out for life. One of our manufacturers makes the following statements:

"The question of having a positive joint is also a very important one. We, of course, feel that our lock joint has proven very satisfactory as it supports itself over loose ground and as the form itself is staked on either side of the joint by means of a wedging section which really locks the form to the stake and makes it possible for the entire form to be further supported on the stake, independent of the softening sub-grade due to the moisture from the concrete, we feel that such a form is contributing to the cause of smoother roads, and yet I want to say that we are not satisfied and we are more than willing to improve the form if it is at all possible. Any suggestion along these lines, will, therefore, be welcomed by us."

This shows the proper attitude and I will say that most manufacturers have the same viewpoint.

Joints between sections on the two sides must not be opposite but should be staggered whenever possible.

One of the first requirements of a satisfactory staking system for road forms is to improve the forms from overturning, settling or changing alignment.

In view of the rigid requirements for a smooth road, which means that there cannot be any break in the grade line, the staking system must perform a second or double function of preventing the form from sagging or settling either at the joints or along its length.

There should be not less than three stake pockets to a 10 or 12-ft. section, preferably an extra stake pocket for emergency purposes or four stake pockets per section. Two pockets located as close as possible to the rail joint, as the joint is the weakest part in the line of forms. If the joints are not held securely, the alignment of the forms is not secure, and depressions at the joints will cause waves in the finished road surface.

The length of the pin will depend on

the firmness of sub-grade into which they are driven; the softer the sub-grade, the longer the pin. The connections and braces vary widely, some designs using none at all, others depend on stiffness and comparatively thin metal for the body of the form, while others use the thicker metal and the braces.

In my opinion the best form and one which we road builders may come to later is a structural section of medium steel which will resist impact better than the softer sections now in general use.

Number of Forms Required

The number of forms required depends entirely upon the speed with which the concrete is poured and specifications under which the work is done. Specifications require that forms shall be set to line and grade from 200 to 500 ft. in advance of the point of placing the concrete; the average being 300 ft. Thus, as the average day's run of concrete is 500 ft. per day and the forms must be left in place for at least 24 hours, about 2,000 ft. of forms are usually required per paver. However, the amount required, depending on the locality, varies from 1,000 to 3,000 ft. When the forms have been selected and arrive on the job, the contractor should look them over carefully and condemn those which are in any way defective, in much the same manner as he does his other equipment.

Many contractors seem to feel that the forms are a part of the engineer's equipment and that if the inspector accepts them his worries are over.

He should realize that the cost of good form setting is one of his heavy items and it costs very much more to set and handle poor forms than it does good ones.

A new form grader is now on the market which may help to cut the cost of this operation.

If wood forms are warped or if steel forms are bent so that there is a variation over 1/16 in. in 10 ft. they are not suitable for use. If top varies, the variations will make an irregular surface.

Forms of any kind should be placed on a solid foundation with even bearing surface in the concrete. When the sub-grade soil will not support the form and weight of finishing machine, tamper, strikeboard, etc., stakes are driven into the ground at frequent intervals to support the base of form.

The sub-grader is a very useful piece of equipment in most instances but it does some damage to forms when being operated over them.

A contractor should take this into account when he is operating in stiff soils.

Forms should always be reset for line and grade after the sub-grader has completed its work.

As important as the forms themselves are the form setter and his assistants. They should always be selected and experienced men, should not be shifted around the job, but should be kept on the forms. A delay in form setting ties up the whole work or outfit. Good work, smooth work has been obtained with poor forms, but the handling and permanence of this work required special skill and constant supervision, so that the labor item more than offsets the cost of better materials.

Abuse of Forms

In visiting many jobs, I have watched them setting forms and noted one thing particularly, that if form is off line, the husky workman picks up a 12 or 16-lb. sledge hammer and gives the form a whack in order to get it in line.

Now, no road form is made to stand such abuse: Many form setters do not know that they can accomplish the same purpose by striking the ground with the same sledge hammer right next to the form in the direction that they want the form to move.

This item, alone, if known by the contractor, would save the forms, and at the same time insure better alignment, better grade and smoothness.

I know one contractor who will not allow the sledge hammer on his work.

Although some specifications call for a thorough tamping under the form along its entire length, such operations are often incomplete as well as insecure, and as the moisture from the concrete penetrates the sub-grade under the form, it then loosens up settlement and means are provided within the form or its staking system to offset this evil. With the forms in place, the work on concreting and finishing commences but careful watch must be maintained in order that no displacement occurs.

The storing and placing of sand and stone on the sub-grade has been pretty well discouraged and with it a source of danger to the forms, but in their place we have the trucks which frequently hit the forms, or bags of cement may be dumped or carelessly stored against them.

The continued action of a finishing machine over concrete will sometimes result in form displacement. The sub-grade under the forms becomes saturated with

water from the concrete, and as the continued trip of the machine brings more water to the sub-grade surface, the bearing power of the soil is greatly reduced, and the forms settle; they may return to true position, but, after the strike off has been made with the form in its depressed position, the damage has been done.

A test of this was made by driving stakes along side of forms; the stakes were driven to the exact grade of the form tops; the concrete was then placed and the finishing machine put in operation. While the machine was opposite the stakes a deflection in the form of 1.4 in. below top of stake was noted. When the machine moved away, the form recovered.

This was the heaviest form made; also the heaviest finishing; but the subgrade was a soft alluvial deposit.

I have in mind two projects using different types of finishing machines where trouble was encountered because the subgrade was soft and the forms settled under the machines. In the first place, the regular precautions were taken to check the depth of subgrade below top of forms between mixer and placing of concrete. The subgrade was unusually soft and of alluvial deposit. The forms settled under the finishing machine slightly, but sufficiently to result in a thinner pavement than specified.

On the other job, a smooth surface could not be secured as the machine continually pushed the forms down or sidewise with the result that satisfactory alignment and grade could not be maintained. The job was finally finished by using lighter templates by hand. A contractor would do well always to be sure his forms and methods of finishing are adapted to the subgrade conditions.

Most state specifications require a checking of the road surface by means of straight edge and if any inaccuracies or lack of smoothness is discovered, they may be corrected. Many a contractor has suffered a considerable loss in profit because his finished road was not smooth enough.

One observer noted that while riding over the concrete road on his trip, he was struck by the uniformity of distance between cracks starting at the edge of the road, these appearing to be approximately 10 ft. apart.

On closer examination, he found that these cracks in almost every case started at the point where the road forms joined one another. He then experimented wtih a straight edge and found that at the point of junction of the ends of the road form rails there was in some cases a slight, sharp depression and in other cases a ridge.

He discovered that this situation occurred on concrete roads where the steel forms used prior to the types brought out in 1924 and occurs on all roads unless the form is so constructed that the joint is absolutely unyielding.

Mr. H. F. Clemmer, engineer of tests for Illinois, has built a very interesting device by means of which a very accurate profile of the surface of a pavement may be obtained automatically.

Profiles obtained with this device on some of the earlier highways are especially interesting in that practically every form joint can be located even though the record was traced several years after construction.

Every surface of a concrete road slab depends on the road form; the under surface because the subgrade is shaped with forms as a guide; the outside edges because they confine the concrete; the wearing surface because all finishing devices rest upon or are guided by the top forms.

Steel forms for road construction have been developed to a high degree, and continued improvement will be required to keep pace with road building specifications which are becoming more exacting as road designs change from time to time.

It is, therefore, realized by contractors and engineers throughout the country that the first cost of the form itself is really a negligible factor when compared with the importance of careful form setting and the riding qualities of the pavement itself.

The day of inadequate forms and careless form setting has past, a better and smoother road is demanded, and it is gratifying to state the fact that manufacturers and contractors are co-operating with engineers to fulfill this demand.

The foregoing paper by Mr. Conner was read at the recent annual meeting of the American Road Builders' Association.

TWO VIEWS OF THE RAIL-TRUCK PROBLEM

The following editorial entitled "Motor Competition With Railroads" was pub-

lished in the New York World of Dec. 22, 1924:

All considerable railroad systems in the country face in greater or less degree the problem of motor-truck and motor-bus competition on free public highways. It is seriously affecting their branch and feed lines in particular.

Many of them are devising ways and means to meet the competition without abandoning the chiefly affected lines, which is a hard thing to gain public consent to. Some of them are substituting light motor-driven rolling stock for the old and heavy steam facilities. Others are looking to electric and hydro-electric development as pointing the way out.

But the Boston and Maine System can see no hope for itself in those directions. It has 1,000 miles of now non-paying branch lines, mostly located in the hill country of Northern New England, in a total mileage of 2,450. It finds that this 45 per cent of its mileage handles only 3 per cent of the whole system's business. It further finds that while these feeder lines never were large earners they have now become a great and growing burden to the system from motor competition operating on improved free highways partly maintained at its own expense as against its own lines opened and maintained at great cost to itself exclusively. It accordingly proposes to abandon the 1,000 miles of line altogether and substitute motor transportation on the free highways instead. And it is moving to get State and Federal consent to the arrangement.

New England has less than 8,000 miles of railroad, and here is a proposition to scrap over an eighth of the mileage! It is a starlting proposal not only for New England but for American railroads generally. It forces to the front as never before a problem which ten years ago was no bigger than a man's hand in the railroads' firmament but which has now spread to darken a large part of their sky. But one thing is certain: Competition on bases so unequal is unjust to the railroads and impossible, and it is up to the public authority which holds them to it to equalize the conditions or let them go. How shall this be done?

Mr. Don C. Seitz of Coscob, Conn., wrote the following letter to the editor of the New York World commenting on the foregoing editorial. Mr. Seitz was for 25 years business manager of the New York World. He is the author of "Joseph Pulitzer, His Life and Letters," recently published. This letter follows:

Commenting on the proposal of the Boston and Maine Railroad to abandon 1,000 miles of unprofitable lines in New England, with the purpose of substituting motor-trucks, you say: "Competition on bases so unequal is unjust to the railroads and impossible." Why unjust and why impossible? For years these branch lines have stifled their communities with high rates and miserable service. When the motor-truck came along, the cement highway showed people a means of escape from an inconsiderate monopoly that capitalized its earning power beyond the limit of reason, held the Legislature in its thrall and denied the public relief. The public at last has been able to relieve itself, and you call this "impossible competition." Instead, it was inevitable competition, which they blindly failed to meet.

IMPRESSIONS OF ENGLISH HIGHWAY PRACTICE

By A. B. Fletcher, Consulting Highway Engineer, U. S. Bureau of Public Roads, Washington, D. C.

During the spring of 1924 I was detailed to study the rural roads of England. With this not unpleasant assignment I was employed during the months of April, May and June and although England did not live up to her reputation for fine spring weather—it rained nearly every day—it was possible to get about without particular difficulty even in the remote country districts. One could forgive the rain for the astonishing beauty of the roadsides which it produced.

In addition to meeting the English road officials, the trip included a journey in a Chandler (American-made) automobile from London to Edinburgh, and a little farther north in Scotland, going up through the counties on the east side of the little island and returning to London by way of the west-side counties, a drive of more than 1,500 miles.

The main north and south roads were rather generally followed but the large centers of population and the manufacturing cities were avoided for two reasons. I wanted particularly to see the rural roads, and the heavy traffic congesting the narrow, crooked streets of the cities, built when riding in a saddle was more popular than any other sort of transportation, was not tempting to an amateur driver whose forbears for some generations had been taught to drive on the right-hand side of the street.

They say that even Henry Ford had to yield to British conservatism and put the steering wheel on the right-hand side before the English would buy his cars. The Chandler car, originally made with the steering wheel on the left side, had been remodeled so that the wheel, clutch pedal and brake were moved to the right side. The gear shift, however, was left in the center and had to be worked with the left hand. One soon learned to make the car go, but the idiosyncrasies of the car together with passing other cars on the wrong side of the road made such a thing as intuitive driving out of the question. It was not difficult, however, to go as fast as the law permits, for in England as in Massachusetts, the legal limit of speed is 20 miles an hour. The law is obeyed equally well in both places, I should say.

The journey, as it was planned, gave an opportunity to inspect a considerable mileage of the two main, north-and-south trunk lines throughout the length of England.

There are many similarities and some differences between the English country roads and the rural roads of the United States. They are perhaps more crooked even than the roads of our older states and the reason for the poor alignment is apparently the same in both countries. In neither country was there any thought of motor traffic or any other sort of fast traffic when the roads were surfaced. Mostly, the roads were improved by putting down hard surfaces within the limits of the then existing rights of way. We seem to be making faster progress in this country in correcting that fault, perhaps not because we are more progressive, as we like to think, but because the urge is greater. The motors have come upon us at a faster rate and in greater numbers, relatively, than in England.

Great Britain still has from 20 to 25 per cent of its highway freight moved by horses while I suppose that in the United States not more than 10 per cent of the traffic is horse-drawn and in some of the States the horses are no longer counted in the traffic census.

But when it comes to the matter of the riding quality of the roads we have very much to learn from England. I saw no road on my long auto journey so rough as are most of our rural roads, but it should also be said that I saw hardly any so smooth as the best of the roads in the United States built by the State highway departments with the Federal-aid stimulant.

The English and American Road Problems Compared

Our road problem is so much bigger than Great Britain's that the reason for the better, average improvement of the English road is apparent. In all England, Wales and Scotland, there are but 177,000 miles of road, cities and boroughs included, as against our estimated mileage of 2,941,000 outside of the cities and towns. England, Wales and Scotland have an average of about 242 persons to the mile of road while in this country there are not more than 35 people to the mile. In Massachusetts, one of our States of dense population, there are about 175 people to the mile.

The English roadside almost invariably is a thing of beauty and an American has to go to Scotland before he feels at home. For some reason, sparse population and lack of money, perhaps, the Scotch roadsides are nearly or quite as barren and unkempt as most of ours are. The English roads, generally, have a wide grass border and there are trees and shrubs everywhere. Sometimes, the line of sight is restricted by the roadside growths but it is plain to understand why even the shrubs are spared.

The drainage water from the roads disappears quickly from the carriageway and flows off in unseen ditches near the right-of-way lines. The turf at the pavement edge is carefully trimmed and kept so just as in a park. Laborers trimming the edge with spades with a tightly stretched cord for a guide were seen, working as painstakingly as if they were trimming a garden border.

The traffic control at bad road intersections in the country as handled by the agents of the Automobile Clubs in co-operation with the police authorities, is wonderfully well done and worthy of much more attention than can be given to it here. In the matter of road signs, however, I was disappointed. I think that on the whole we mark our roads, at least so far as direction signs are concerned, better than it is done in England.

Nearly all of the roads inspected were of some bituminous type, tar-mac, tar macadam, asphalt, tarpainted, etc. In my 1,500-mile journey not more than a mile or two of the road in the open country was recognizable as being of the cement concrete type, and some of that had been

covered with tar or asphalt. I do not imply that no cement concrete surfaces been laid on the rural roads but seemingly most of the work of that type must be in the cities and towns. The English road officials from Sir Henry Mayberry, Chief of the Road Department of the Ministry of Transport, down to the surveyors of the smaller counties seem to be almost a unit in believing that they can not afford to scrap the great mileage of bituminized roads which they have constructed even if it can be proved that the concrete type is more desirable from the viewpoint of maintenance costs, which they seem to disbelieve. They seem to be thoroughly wedded to the bituminous types of construction.

The reason for their preference is clear when one sees the carefully planned grades, long established, with sodded shoulders, drainage ditches and entering driveways, and when one realizes the great expense which they have incurred in putting in the heavy road foundations. Notwithstanding the large costs of maintaining the bituminous road surfaces, the Englishman is slow to adopt a road type with which he is not familiar and he is entirely willing that his American cousin shall make what he calls the experiments. He wants proof of the reputed low cost of maintenance of concrete roads and in his doubting conservatism he will not admit that the relatively few years of life of the American concrete roads have given them any "history" worth talking much about.

How large the upkeep charges are for the bituminous roads is shown in some figures published by the Ministry showing the annual cost of upkeep on four Class 1 roads leading out of London into the provinces. The total length of the four roads is 321 miles and the report says: "The annual cost of upkeep taken over the whole length of each road ranges from $3,360 to $4,704 per mile.

Assuming the average width of the carriageway of these roads to be 30 ft., and assuming that $4,000 per mile fairly represents the average annual cost of upkeep, we see that these four roads cost not less than 22½c per sq. yd. for maintenance. This annual outlay would appear to be sufficient to renew completely the wearing surface as often as once in five years. The figures, the report says, do not include any capital outlay for the roads in the past.

I have been unable to find a statement showing the mileage or square yardage of concrete roads in Great Britain. The handbook of the British Portland Cement Association states that 281 concrete roads had been built up to June, 1923. Of these, nearly 79 percent were built after the year 1920. Many of the roads were very short, some less than one-half mile in length, and evidently the total yardage was not sufficiently impressive to be set forth in the handbook.

On the other hand, much of the new arterial road work in the vicinity of London is of the cement concrete type, some of it 50 ft. in width with the slab 8 ins. thick, and the work very well executed, some American equipment being employed.

There are so many types of bituminous road in use or offered for use in England that the patentees have had to tax their ingenuity to find names for them all, but from my observation I believe that the great bulk of the pavements are either some sort of penetration macadam, tarmac, or merely surface-painted.

I was much interested in looking for wavy conditions or corrugations in the surface of the bituminous roads. The county surveyors will tell one that they have waves in their pavements and they seem to know what one is talking about when one speaks of corrugations, but their waves are not like our waves for I found very little, practically no evidence of the corrugations which are so prevalent in our bituminous pavements.

Their methods of spreading the bituminous material are much like ours except that they work more slowly than we do, perhaps more carefully and skilfully, but I am forced to the conclusion that the apparent superiority of the British bituminous roads is due very largely to their thick, heavy foundations and in some measure to the use of curbs to confine the pavements at the sides.

Almost without exception, the English road is built with what they call "hard core" as a foundation. Hard core may consist of almost any hard material laid as a foundation for the full width of the carriageway. The stones are large, sometimes as lears as 8 ins. in longest dimension and often as large as the thickness of the layer will permit. The hard core layer is usually from 8 to 12 ins. in thickness. Strong, hard slag seems to be a popular material but when that is too costly and brick bats or stones from walls or buildings are available,

they are put into the road. The point is, of course, to secure a hard, unyielding base which will not hold capillary water. The county surveyors are beginning to wonder if these hard core foundations, strong as from our viewpoint they seem to be, are going to be heavy enough for the future motor traffic. When we consider how few of our rural roads have any foundation at all under the 5 or 6 ins. of bituminous stones, do we need to look much further for the cause of the corrugations, or to explain the apparent superiority of the British roads?

The English seem also to be completely convinced of the need of substantial curbs to prevent the lateral movement of the pavement. All of the new work with which the Ministry of Transport has to do is provided with curbs, and the county surveyors generally are installing curbs in connection with their widening work and extensive repairs.

Bases Twelve Inches Thick

Illustrating the extreme care in the matter of road foundations which some of the county surveyors are taking, Mr. C. F. Gettings, of Worcester County, told me when I was looking over some of his work with him that because of the bad sub-soil with which he has to deal, he first lays a stratum of "blinder," or cinders, 3 ins. thick over the subgrade, followed by a layer of slag 6 ins. thick, then a layer of 3-in. slag to a thickness of 3 ins., then 3 ins. of tar-mac and finally a dusting on the top of pulverized slag. Thus, he has 12 ins. of material in place before he lays the wearing course which he prefers shall be tar-mac. Tar-mac is crushed slag, heated and mixed with a refined tar at the works where the slag is produced and shipped cold to the highway job.

When conditions permit him to do so, Mr. Gettings employs what we, in this country, have come to call the stage-construction method. First, after rolling as much as is effective the 6-in. layer of slag he turns on the traffic further to consolidate it. He does the same with the 3-in. slag layer, sometimes giving it a light tar treatment and allowing the traffic to pass over it for a considerable period, but not after it shows any sign of distress. In this manner he makes sure, before the wearing course is laid, that he has a firm hard base for it, and that there will probably be no further settlement of his foundation after the pavement is completed.

Some of the best bituminous pavements that I have seen anywhere were built under Mr. Getting's directions. The traffic over the main Worcester County roads is called heavy. The county is in the Midlands, one of the regions of great manufacturing activity. The traffic census, taken by the Ministry in August, 1923, indicates that the roads are in the group of 1,000 to 1,500 tons per 16-hour day. We would not consider that to be a very heavy traffic, but Mr. Gettings thinks a carriageway, 24 ft. wide and of the thickness before stated is needed for the main roads of the county where the sub-soil is bad.

The Cost of English Labor

In the United States, such substantial work would cost much more than the public is accustomed to pay for the rural highways. The English feel the high cost of their road work, too. Common labor in 1924 was receiving the equivalent of 25 cts.per hour, a price which the English employer thought was outrageous, yet we at that time were paying more than double the English hourly wage. Living standards and cost of living are different, but I do not believe the disparity is so great as I had been led to believe.

In July, 1924, Portland cement cost in London about $2.22 per barrel, American basis, and other materials of construction seemed to be not greatly lower in price than in the United States.

The arterial roads near London are of great interest. They are being built in part to supply the general need for more roads, in part to by-pass through traffic so that it will not have to go through the narrow, already congested streets of the metropolis, and in part to provide work for the unemployed.

In England, in 1924, there were more than 1,000,000 persons "on the dole," or supported to a greater or less extent by the Government. Any public work which could be found for these unemployed was welcomed, and for several years the construction of the arterial roads in the Greater London area and the by-pass roads around the cities and towns in the provinces has provided work for many men. In 1922-23 there was set aside more than $31,000,000 for the Road Fund Unemployment Program.

In the Greater London area alone, 165 miles of the arterial roads, including the widening and straightening of some roads, are either under construction or

planned for, the total estimated cost of the work being in the vicinity of $60,000,000.

All of this work is being done on a large scale. Rights of way, 100 to 120 ft. in width are being secured and with much delay and difficulty. When houses are in the way and must be demolished, the public authorities must provide other houses elsewhere to shelter the tenants, so great is the housing shortage.

The carriageways of the most important arterial roads are to be 50 ft. wide and curbed. Sidewalks and planting strips are provided for and iron fences are installed along the right-of-way lines. On the Great West Road all pipes, sewers, water and gas and all electric wires are to be placed in conduits under the sidewalks and planting strips. One section of this road under traffic in 1924 was said to have cost at the rate of $864,000 per mile.

In the arterial road and by-pass work very low grades are insisted upon, the alignment is as nearly perfect as can be obtained and no effort seems to be spared in securing the best results in all branches of the work. The pavements, or many of them, are of the cement-concrete-base type laid in most instances with the expectancy of covering them later on with asphalt, but in some cases the concrete is being allowed to take the traffic for the present. The concrete slab, 8 ins. thick and reinforced, is said to be costing about $2.40 per sq. yd.

English Road Administration

The Ministry of Transport took the place of the Road Board in 1919 and, under Parliament, it is the highest road authority of Great Britain. Its organization is somewhat like that of the Bureau of Public Roads. The Road Department of the Ministry is in charge of a chief, Sir Henry Mayberry, with Col. C. H. Bressey under him in the capacity of chief engineer who, in turn, has a corps of divisional engineers located at various places throughout the country in direct charge of the operations.

The revenue which the department has for road purposes, derived almost wholly from the registration fees paid on account of the motor vehicles, amounted in 1924 to about $72,000,000. This is about the same sum that Congress has been appropriating recently for our Federal-aid work, but here the likeness ends. Col. Bressey told me that the annual revenue which the department received represented, fairly closely, one-third of the total sum spent annually by Great Britain for all highway purposes. Such a sum, approximately $216,000,000, would not go very far toward paying the annual highway bill of the United States, which in 1922 was estimated to amount to more than one billion dollars.

The Ministry has divided the roads into two categories, known as Class 1 and Class 2, and the present policy is to allot to the counties not more than 50 per cent of the cost of improvements on Class 1 roads, and not more than 25 per cent to such work on the Class 2 roads. Roads less important than Class 2 roads are merely local in character and they receive no money from the Ministry.

In England, Wales and Scotland, the total mileage of Class 1 roads is about 23,000 miles, and the Class 2 roads aggregate about 14,000 miles. The total mileage of all roads, including the merely local ones, is given as 177,321 miles so, roughly speaking, the Ministry is concerned with about 21 per cent of the total mileage of the country.

Gasoline Tax Abandoned in 1921

Prior to January 1, 1921, at which time the present Road Fund was established, there had been in effect a tax on gasoline or "motor spirit," speaking in the language of the country, by means of which most of the grants made by the Ministry were financed. After the year 1915 this tax was at the rate of about 12 cts. per gallon. Beginning with January 1, 1921, the tax was abolished and in place of the gasoline tax as a revenue producer a tax of about $4.80 per horse-power of the motor vehicles was substituted.

This tax is still in effect and the owner of a Ford car, for example, pays into the public treasury annually very nearly $100 for the privilege of driving on the British roads. The high registration fee has fostered the manufacture and use of low-powered cars and special attention has been given to small-cylindered motors and high piston speeds.

The Ministry does not favor a proposed plan to return to a gasoline tax which the motor interests are pressing for, chiefly, I believe, because the officials dislike to abandon a source of assured income for a plan which they think to be less sure. They say they need at least $72,000,000 per annum for the roads; that the present taxing plan will surely produce that revenue, and that their experience with the collection of the gasoline tax prior

to 1921 has not left happy memories. The old, relatively high gasoline tax was doubtless evaded in many instances. Sir Henry Mayberry says that while the motors were increasing in numbers from year to year in an astonishing fashion, the receipts from the tax remained nearly constant. Much of the gasoline and the kerosene imported into England nominally for heating and manufacturing purposes doubtless found its way into the tanks of the motor cars.

To conclude this somewhat sketchy and superficial summary of some rather large subjects, I believe that in speed of road construction, in the matter of road equipment of all kinds, as concerns motor vehicle regulation, highway financing, and research and experimental work generally, we do not have much to learn from Great Britain.

In matters of road location we can see there in aggravated form the same mistakes which have been made in this country, particularly in the older States, where we have put down expensive pavements on faulty locations with unnecessarily tortuous alignment—a timid following of the line of least resistance—using rights of way good enough, perhaps, when horses did the work, but sadly inadequate for our present day motorized traffic.

It is doubtful if we can hope to equal the bituminous roads of England until we pay more attention to the foundations. We should either follow somewhat after the English methods or develop some substitute, possibly less costly, which will be as effective.

The foregoing paper by Mr. Fletcher was read at the 1925 meeting of the American Road Builders' Association.

ECONOMICS AS APPLIED TO ENGINEERING PROJECTS

By C. A. Morse, Chief Engineer, Chicago, Rock Island & Pacific Railway Co., La Salle St. Station, Chicago, Ill.

(Concluded from February number)

I am assuming that a large percentage of the members of the Iowa Engineering Society are employed on public works, and it is for that reason that I am appealing to them for the benefit of the public at large and to the credit of the engineering profession to make a study of the economics in connection with expenditures of public money.

The railroads are the largest individual taxpayers in the various communities where they are located, and they are called upon to pay taxes, like the balance of the public, for public improvements. But in connection with this epidemic of good road construction there is a demand on the railroads, in addition to paying their proportion of the taxes, to contribute 50 per cent or more to the cost of separating grades between the railroads and public roads. This is another case where, in my opinion, a careful study of the economics of the question would show that many of these grade separations are not warranted; that the amount of money invested in them is such that they are not earning a fair return to the public and to the railroads, whose money is used in their construction. Many systems of signaling crossings of public roads and railroads have been developed, just as there have been signaling systems developed in the large cities for crossing of streets, whereby the traffic on one street is required to stop for a certain length of time while the traffic on the street at right angles to it is permitted to proceed, and vice versa. I doubt very much whether the time of the average driver of an automobile in the small towns and in the country is any more valuable than that of the driver or the occupant of a similar conveyance in the city, yet it is found absolutely necessary in the city to make the traffic at these crossings intermittent, and in my opinion, the same thing could be done to good advantage with the crossings of public roads and railroads in the country and in the small towns, and I believe that if these matters were studied carefully by the engineers who plan these projects, it would be found that signaling is the proper way to handle these matters rather than the construction of expensive overhead or under crossings.

You may, from the fact that I happen to be connected with a railroad, feel that I am biased in this matter, but I want to assure you that such is not the case, as I am trying to consider this matter from the point of view of the best interest of the public, as I believe that in the expenditure of public money the same care should be given that has to be given by corporation and public utilities in the expenditure of their money.

My attention has been attracted to this matter of the reckless expenditure of public money for many years. I was

chairman of a sub-committee some years ago of the Chicago Chamber of Commerce when the question of metering the water supply of Chicago was referred to this committee, and it was shown at that time that an immense saving could be made to the city of Chicago if they would require the installation of water meters and collect for the water furnished in proportion to the amount used. The matter has been up every few years and is, today, one of the live questions in Chicago; but it has been, up to this time, impossible to make the politicians look at this thing from an economic standpoint. I believe, however, that it will be accomplished within the next year or two in Chicago. But it is just an example of the complete lack of study of the economics of practically all questions where public money is being expended.

I would say that the Western Society of Engineers, located in Chicago, has been one of the prime factors in constantly bringing this question up and much of the credit will be due them for the final installation of the meter system in connection with the Chicago water supply.

The Western Society of Engineers has a committee on "Public Affairs," and they make a study of the various public questions that come up from time to time and try to give to those in authority the benefit of the conclusions of this committee and of the society on these questions. And I want to suggest to your Iowa Engineering Society that you get interested in this same thing. There is nothing you can do that will be of greater benefit to the public at large and will reflect greater credit on your engineering society than to bring the public to realize the necessity of a study and discussion of the economics in connection with the expenditures of public money.

The foregoing paper by Mr. Morse was presented before the 1925 meeting of the Iowa Engineering Society.

REMODELING SEWAGE TREATMENT PLANT AT ROCHELLE, ILLINOIS

By Robert Isham Randolph, Consulting Engineer, Randolph-Perkins Co., Chicago, Ill.

The city of Rochelle with a population of approximately 3,500, is served by a separate sanitary sewer system, constructed in 1907, emptying through an outlet sewer 15 ins. in diameter into a septic tank with two compartments each approximately 60 ft. long, 10 ft. wide and 8 ft. deep. It is highly probable that this tank turns out an effluent, at certain seasons of the year, that is worse than the raw sewage entering the tank and the pollution of Kyte Creek by city sewage and other wastes has been the cause of frequent complaint throughout the past five years.

Sewage purification is a comparative term and the degree to which it is necessary to purify sewage to prevent nuisance depends upon a number of collateral conditions. In order not to impose an unnecessary degree of refinement in the treatment of the city sewage and a consequent unnecessary expenditure of public funds, the engineers first sought a ruling from the state authorities as to the degree of purification that would be required for this plant.

The Department of Public Health of the State of Illinois ruled that "More than good tank treatment" was necessary and the Division of Waterways of the Department of Public Works recommended "nothing short of secondary treatment." Primary and secondary treatment, as indicated by both of these authorities, was therefore adopted as a basis for the design.

Selection of Process

In the present state of the art of sewage disposal, several processes have been developed but they all have a common purpose and they all do the same thing in different ways. Fundamental to each of them are several mechanical and biological divisions as follows:

Coarse sedimentation—mechanical.
Coarse screening—mechanical.
Fine screening—mechanical.
Sludge digestion—biological.
Aeration—mechanical and biological.

Before proceeding with the design of the plant, the engineers secured the cooperation of Dr. A. M. Buswell, chief of the State Water Division, in making analyses of the sewage and trade wastes tributary to the city sewers. A number of samples of raw sewage and of trade wastes were taken. Dr. Buswell's comment on the analysis of raw sewage at the septic tank is as follows:

"There is nothing particularly remarkable about the analysis of the sample of raw sewage except perhaps the very high total solids. Otherwise, it is about what would be expected of a sample of sewage from a residential community."

The principal trade wastes entering the city sewers are liquors from the washing and dye vats of the Caron Spinning Mills and the purpose of the investigation of these wastes was to determine whether they contained any acids or other elements that would interfere with the biologic processes of the sewage disposal plant. Dr. Buswell's conclusion drawn from these investigations is that "there is no apparent reason why it could not be handled in the city disposal plant. If any difficulty is met with in the handling of these wastes in the municipal plant, it will probably arise from the fats and soaps. If such difficulty should arise it would be a comparatively small matter to install grease traps and the recovered grease will, in a large measure, offset the cost of installation and operation of the traps."

Dr. Buswell's conclusions, as expressed above, indicate that the wastes from this plant may be handled by the city sewage disposal plant, but they also indicate the necessity for a thorough mixing of dye liquors and wash liquor in a tank to be provided at the Caron Spinning Mills, and the installation of a fine screen to remove wool lint, either at the mill or at the city sewage disposal plant.

Field Investigation

Due to the proximity of a stone quarry and certain outcrops of rock in the Kyte Creek, it was thought advisable to make borings at the site of the proposed improvements to determine the nature of the excavation that might be encountered. For this reason the engineers made a number of borings with an earth auger at the points and to the depth of the proposed construction. No rock was encountered in any of these borings and the estimates of cost of excavation were based upon the nature of the material revealed by the borings. The first borings disclosed a coarse sand underlying the top soil for a depth of 3 to 4 ft., and this suggested the possibility of utilizing this stratum as a natural sand filter. Further borings were therefore made over the area necessary for a sand filter but the results were disappointing. The first sand discovered was apparently a pocket in the vicinity of the septic tank and it did not continue as a uniform layer under the entire area. The only other alternative was the construction of an artificial filter.

Elements of Design

The present daily sewage flow from a population of 3,500 is estimated at 350,000 gals. To provide for the normal growth of population the plant is designed to treat the sewage from a total population of 5,000, with a maximum daily now of 500,000 gals.

The separation and sedimentation compartments provide a capacity of 2 cu. ft. per capita and a detention period of 2 hours. The sludge digestion tank provides a capacity of 2 cu. ft. per capita. The sludge bed provides a capacity of .35 sq. ft. per capita. The sprinkling filters are designed on the basis of 20,000 population per acre.

The Plan

The present septic tank is to be remodeled for use as a separate sludge digestion chamber and a new sedimentation tank is to be built next to it on the west side. The raw sewage from the 15-in. main sewer enters the inlet channel of the old septic tank as at present, but the present inlet ports are to be closed up and the sewage passed through a new opening into the inlet channel of the new settling tank. There are five inlet ports or gates from this channel leading into the tank and a scum baffle in front of these gates to check the flow and aid in precipitation of solids. The raw sewage will flow through the settling tank from north to south, the period of detention being estimated at two hours. During this detention period the suspended solids will be precipitated into the two hopper bottoms in the tank and as this sludge accumulates it will be pumped through the sludge blow-off pipes by a 150 g. p. m. centrifugal pump, into the sludge digestion tank. This pump is to be electrically driven, but manually operated, and the sludge will be drawn from time to time as it accumulates so as to prevent septic action and bubbling or foaming in the settling tank. The pump operator can see the pump outlet, observe the nature of the discharge and stop the pump when the discharge changes from sludge to clear water. Sludge shall be withdrawn from the settling tanks to the digestion tank daily. The liquid sludge so stored in the digestion tank undergoes a biologic change and by the action of the anaerobic bacteria the offensive and unstable elements of the raw sewage are reduced to an inoffensive and stable mineral residue. This digested sludge is drawn off from the bottom of the hoppers through the sludge blow-off pipes by the same pump that originally drew it from the settling tanks. Four gate valves on the intake

side of the pump control the suction from any one of the two settling tank hoppers and the two sludge tank hoppers and two gate valves on the discharge side of the pump control the discharge to either the digestion tank or the sludge drying bed. There are risers from each of the four suction pipes to the pump house floor level. These risers are provided with cover plates which may be removed to permit cleaning out the pipes with flexible rods in case of stoppage. The cover plates are also to be tapped for a 2-in. diameter water pressure line running to the 350 g. p. m. pump. This will provide a means for cleaning out the suction pipes wtih water pressure in case of stoppage and will also serve to agitate and loosen the settled sludge when it is desired to draw it off. The ripened or digested sludge is pumped onto the sludge drying bed where it is permitted to drain and dry out and is then disposed of as filling or fertilizer. In some plants a considerable local demand has been developed for this dried sludge as fertilizer. Another 6-in. suction line equipped wtih shear gate inlets is provided to draw off the intervening liquor in the digestion tank between the sludge and the scum and return it through the 150 g. p. m. pump to the inlet end of the settling tank.

The liquid portion of the clarified sewage flows toward the outlet end where any unsettled scum or colloidal matter is intercepted by a baffle in front of the outlet ports. This scum should be skimmed from the surface as it accumulates and emptied into the sludge digestion tank through the scum wiers. The clarified sewage which passes under the scum baffle through the outlet wiers is collected in a wet well in the south end of the old septic tank. There is not sufficient head available at this site for the gravity operation of a sprinkling filter so it is necessary to resort to further mechanical aids to the process. Next to the wet well is a dry well in which is installed two centrifugal pumps with a capacity of 350 gals. per minute and 200 gals. per minute, respectively. These pumps are driven by electric motors operated by float switches, and deliver the clarified sewage to a dosing tank which alternates the flow through its two ports to the two halves of the sprinkling filter. This mechanical dosing tank was invented by Mr. L. K. Sherman of the Randolph-Perkins Company and the first one built for the city of Chicago Heights is in successful operation.

The operation of the sprinkling filter is a combination of mechanical and biologic processes. The clarified sewage coming from the dosing tank is delivered through the pipe system to the sprinkling nozzles under a head sufficient to distribute it in a fine spray over the bed. It is partly aerated in the spray, takes up oxygen from the air and falling upon the rock bed of the filter, percolates through the interstices between the stones, absorbs more oxygen, deposits any remaining suspended solids and is subject to the biologic action of the aerobic bacteria which form upon the filter and feed upon the microscopic organisms in the sewage. The reason for alternating the dose upon different portions of the bed is that these bacteria require air to sustain life. The dose must be applied gently so as not to wash the bacterial jelly from the stones and there must be a period of rest between doses so as to permit the bacteria to grow. The liquid sewage, after undergoing this mechanical straining and biologic treatment in the filter, seeps along the floor to drains, built in the concrete and covered with concrete slabs, whence it is conducted to a main floor drain and thence through a vitrified tile to Kyte Creek. There is no final sedimentation of the effluent from the sprinkling filter.

The foregoing paper by Mr. Randolph was presented at the 1925 meeting of the Illinois Society of Engineers.

SOME RESULTS OF THE COOK COUNTY (ILL.) TRAFFIC SURVEY

By George A. Quinlan, Superintendent of Highways, Cook County, 909 Court Court House, Chicago, Ill.

The traffic situation in the Chicago Regional area has reached the point where immediate and drastic action is necessary if we are to prevent a complete breakdown of our highway transportation service. At the time the Federal Aid law was passed in 1916, the Bureau of Public Roads estimated that it cost more on the average to transport agricultural products from the farms to the shipping point than all the rest of the charges to New York and even to Liverpool. The hard road system changed that situation, but we of Cook County are fast approaching the time when a somewhat similar condition will exist due to the terminal charges in the

Chicago district. The expenses of traffic congestion are difficult to estimate, but if all factors, such as loss of time, spoilage of perishables or expense of so preparing perishables as to prevent spoilage and increased gasoline consumption are taken into account, the total is certainly large enough to deserve the earnest consideration of all public officials charged with highway construction in terminal areas.

The Problem

To study this entire problem in Cook County, a traffic survey was made during the summer and fall just past. I regret that the tabulation of the mass of data obtained has not been completed, and so no recommendations can be made. However, I can give you an outline of our problem and the methods we are taking to reach a solution which will be based on a comprehensive and scientific study of present conditions and an estimate of future growth.

Growth of the District

Chicago and Cook County are rapidly increasing in population. At the last Federal census in 1920, the population was slightly over 3,000,000, and this has already increased to about 3,500,000. A study of this growth shows that the suburban areas surrounding the city are increasing much faster than the city itself. Since 1900, the time of the introduction of the automobile as a factor in our transportation facilities, the population drift has been steadily toward the cities and villages within thirty miles or so of the loop. In 1900 about 92% of Cook County's population lived within the city limits of Chicago, while in 1920 this had decreased to about 88%. This may be partially explained by the graph of the population per square mile. The population within the city rapidly increased to a high point of 14,000 per square mile in 1880, and during the next decade an area of about 133 square miles was annexed which more than trebled the area. Since then the density has increased until in 1920 it reached about the same point as in 1880. From this we may expect that either the city will again extend its limits or the suburban centers will increase more rapidly in population. The increase in the population in the outlying districts is more clearly shown in the chart of the population per square mile of the county exclusive of the city. With the exception of the decade from 1880 to 1890 mentioned when the city annexed a large area, this growth has been continuous and gradually increasing in rapidity. As stated, this has been more marked since the introduction of the automobile.

In regard to the number of motor vehicles which our highways must serve, as we all know, this has been phenomenal. With the exception of the war years, the growth has been continuous and at an ever increasing rate, until last year there were 350,000 motor vehicles in Cook County. The estimate of future growth is based on two factors, the increase in population and the increase in number of cars per capita. I do not share the belief in some quarters that the saturation point has been nearly reached. I think that the increase in cars per capita will continue until at least 1930 and possibly beyond that time.

Highway Progress in the County

What has been done to provide for the immense traffic movement that takes place in this county, and how are we planning to provide highways for the needs of the future? At the close of the 1924 construction season there had been built a total of 346 miles of pavement in the county. The possible future construction by State and County is about 95 miles a year over a five-year period. Since 1920 the highway construction has not kept pace with the increase in automobile registration. Although in 1920 there was 1.5 miles of pavement per 1000 motor vehicles, this has dropped to only 1.0 mile in 1924. Even with the 95 mile yearly program I have outlined, by 1930 we would only reach the 1.5 mile mark again. In other words, such a program will do little more than keep pace with the rapidly increasing registration.

Stations Established

Facing such a situation as I have outlined, we decided to ask the best possible minds obtainable to act as consultants in the solution of our problem. The United States Bureau of Public Roads agreed to make a traffic survey of Cook County in co-operation with the Cook County Highway Department. Stations were establishd throughout the county where data would be secured. Of the 87 stations, 17 were designated as weight stations, 56 were recording stations and 14 in the city were called Chicago Density stations. At all these stations extensive data was secured, except those stations within the city of Chicago, at which density counts only were made. Data was obtained from

each truck passing the weight stations. With the exception that no weights were obtained, practically the same data was obtained at the recording stations. The weight stations were occupied six days a month, while the recording and Chicago density stations were occupied three days a month.

The information required to fulfill the purposes of the survey embraced not only the data obtained by the field parties, but also the results of some economic studies as well.

Amount of Traffic

One of the interesting facts brought out by the traffic survey was that approximately 125,000 vehicles pass the city limits every day through the 13 entrances which are now paved. This is an average of nearly 10,000 vehicles per entrance, but of course some roads carry far more than their share of the burden. All the traffic originating in the southeast one-third of the state theoretically enters the city at Halsted Street, all from the central one-third on Archer Avenue, while the rest of the state is better served, having several entrances to carry its traffic. I said theoretically, because an examination of a flow chart of total traffic shows that less than 20% of the traffic from the south uses Halsted Street, whil 80% of it enters the city over Western Avenue. As all who are familiar with the locality know, this is due to the very poor condition of Halsted Street within the city limits and to the great delay caused to traffic by the grade crossing with the Indiana Harbor Belt line just south of the city limits. Here we have the condition of all this traffic detouring to Western Avenue, and a great part of is coming back to Halsted Street farther north, a detour of four miles. A similar condition exists on Archer Avenue. The traffic entering the city over that road is almost negligible, the motorists all preferring to take the detour which leads them back west across the river and north to Ogden Avenue. Here they combine with the already heavy traffic from the west to make Ogden Avenue one of our most crowded entrances.

Traffic Congestion

But notwithstanding this condition of all the roads feeding into the city over a few entrances, it is not the traffic from downstate which causes the congestion on our highways. The present system is ample to take care of that movement. It is the traffic which originates within our own county that causes the congestion. Referring again to the south entrances to the city, the average daily traffic on the Dixie Highway in Steger at the south county limits was 5,216 vehicles, while this had increased 260% by the time the city limits were reached, at which point Western Avenue and Halsted Street combined were carrying 18,905 vehicles a day. Similarly on Lake Street near Bartlett, the average daily movement was 2,085 vehicles, which by the time Melrose Park was reached had increased 220% to 6,642 vehicles per day.

The truck movement is relatively not very different from that of total traffic.

Highway System Studied

While the traffic survey was being carried on, we made some studies of our highway system as a whole without regard to pavements. To facilitate this study, the county and the surrounding territory was divided into twelve sections as shown, each 17 miles north and south and 12 miles east and west. For each area two maps were drawn, one showing only the east and west roads, and the other only those running north and south. These show clearly how very few of our highways are continuous over even this small an extent of our county. The southwest part of the county illustrates this deficiency very clearly. This area is from the Dixie Highway west and there are not through north and south roads in this entire area west of the Dixie and even that has a jog to the east of about one-half mile north of Chicago Heights. This section is but little better off in regard to east and west roads, there being no continuous roads between the Lincoln Highway at the north limits of Chicago Heights and 111th Street near the north boundary of the section, a distance of over 12 miles, and on 111th Street it is necessary to jog to the south about a quarter of a mile at 104th Avenue.

Why are so many of these roads discontinuous? Because when they were originally laid out the need of thorough routes for fast moving traffic had not arisen and since that time the financial condition of the townships was not such as to allow them to open many new roads.

Legal Delays.

Another reason why so few new roads are being opened is the very cumbersome process which has been set up by the Legislature, which must be followed in opening a road. First, a petition of

at least twelve land owners living within two miles must be filed, asking for such an improvement. Then if it is decided to open the road and an agreement can be reached with the land owners whose property is to be taken, it requires from 18 months to two years before funds are available for payment of the claim. As possession cannot be taken until payment is made, it can be clearly seen how long and laborious a procedure is necessary. The county itself has no jurisdiction to open any road unless such road lie on a state aid route.

Physical Barriers

Besides the legislative difficulties, there are several physical features which influence or determine the location of our highways. The main physical features in Cook County are the rivers. Running southwest from the city are three parallel streams, the DesPlaines River, the Sanitary Canal and the old Illinois and Michigan Canal. The location of a road across these streams is so expensive that at present in a distance of 20 miles there are only three crossings, one at Lemont, another at Willow Springs and the third at Summit. This factor limits the location of highways to a lesser extent all the way up the DesPlaines River as far as Wheeling.

Other Barriers to Highways

Chicago has become the greatest railroad terminal in the country and its railroads have been forced in many instances to place their large yards and shops outside the city limits. These yards are practically insurmountable barriers to highway location, as grade crossings are out of the question and the cost of either viaducts over or subways under multiple track layouts is prohibitive.

Another barrier that is rapidly becoming a very important one is the "special use area." A tract of ground once set aside for a cemetery or a golf club and which has been improved for such use influences in a large measure the location of our highways. Although such areas demand reasonable access to a paved highway, any attempt to obtain from them any right of way for highway purposes usually meets with strong opposition. Much of the land around Chicago is devoted to such uses.

In the southern portion of the city of Chicago large areas have been improved with vast industrial plants. These demand highways for the transportation of their product, but as in the case of golf clubs and cemeteries are barriers to highway location which cannot be surmounted.

These factors are increasing in their importance as the years go on and we must either buy right of way in the near future for highway extensions which will be necessary, or devise some means of preserving rights of way so that when we are ready to purchase them, we will not find that expensive improvements have been placed upon them.

All these factors deserve and are receiving our earnest consideration in the laying out of an efficient highway system.

The Projected Plan

At the conclusion of traffic survey last December, a conference was held in Chicago of all the jurisdictions interested in highway development in the Chicago area. At this conference there were represented the United States Bureau of Public Roads, the State Highway Department, the Cook County Highway Department and the Chicago Plan Commission. An agreement was drawn up which to my mind is one of the most forward looking steps for highway development that has been taken. This provided that a plan for the Chicago Metropolitan District should be drawn up which would meet with the approval of all the jurisdictions I have mentioned, and that after such approval no party would make any major changes in the plan without conferring with the other parties in an attempt to reach a solution satisfactory to all. No jurisdiction loses any of its sovereignty, because in the event that the conference fails to reach an agreement, any member can take such action as it sees fit. The agreement simply brings us together to unite our efforts so that future highway development will be on an efficient basis, the various bodies co-ordinating to produce the best system possible.

This is our problem and our method of attacking it; as to the results, they will not be ready for some time yet, but we have high hopes that from concerted effort a system of roads will be built near Chicago which will serve efficiently and without undue congestion or delay the immense traffic which the future is sure to bring to the city gates.

The foregoing matter is from a paper read by Mr. Quinlan before the recent Short Course in Highway Engineering held at the University of Illinois at Urbana.

COOPERATION BETWEEN ENGINEERS AND CONTRACTORS

By O. W. Crowley, Executive Secretary, Central Branch, Associated General Contractors of America, 710 S. & L. Bldg., Des Moines, Iowa.

I wish to suggest a few methods in which engineers can cooperate with contractors, and also benefit the communities which they serve. The engineer occupies the same position in construction as the judge in legal affairs. It is not only necessary that he be honest, but he must also be fair to both parties to a contract. I must admit that my opinion of some engineers has changed greatly after reading some of the contracts they have prepared for public construction. Here are a few sample clauses that have come to my attention:

"The city reserves the right to lay or relay all necessary conduits, gas, water or sewer pipes, subways or other structures during the progress of the work before its completion."

"That any work herein contracted for may be omitted at the election of the party of the first part, and no claim for damages, or prospective profits shall be made because of such omission."

"The contractor will suspend the work of construction herein contracted for within three days' notice so to do from the city engineer without claim for damages resulting from such suspension."

No sane man should sign that contract. However, contractors do it, and you may rest assured that the city pays a royalty for the use of these clauses. Your committee on standardization has done considerable work on a standard contract. If you adopt a fair contract and put it into general use, you will render a real service to the state in the elimination of waste. Each of your requirements costs the public money. So then any requirement which does not contribute to the quality of the improvement is directly responsible for waste or extravagance.

We find that plans and specifications in most instances are fairly thorough. The budget law requirements will undoubtedly improve the quality of plans and will have a far-reaching effect in raising the standard of engineering. In this connection, I want to relate an incident which recently occurred. An engineer on a municipal paving project forgot to include expansion joints or calcium chloride for curing. He adopted what he assumed to be the easy course, that is, he asked the contractor to furnish this material and apply it after the contract had been signed and work started, and he thought the contractor should not be entitled to any extra compensation. Few engineers would endorse any such procedure, and it might assist in bringing about better cooperation if the society had a committee on contractors' relations.

On construction work, there is often a tendency on the part of the inspector to interfere with the men. Now he doesn't do this intentionally, and as a general rule he is convinced that he is actually expediting the work by calling the attention of the laborer to a particular phase of the work rather than taking it up with the foreman or superintendent. This practice has a tremendous influence in breaking the morale of the organization and in creating prejudice between the engineer and the contractor.

One of the chief criticisms I have had called to my attention is the delay in paying for work either in estimates or in final payment for the completed project. This delay is a serious proposition for the contractor, particularly in his relations with the banker. The added interest on the money is a mere trifle in most cases. The lack of definite information as to the amount of the estimate, and the date it will be received destroys confidence. Many bankers are today judging the engineer by the promptness with which he meets the obligations of his community and the judgment with which he prepares his estimates.

The question of day labor construction has probably been discussed more than any other subject. Experience has demonstrated that the engineer who recommends that public construction be performed by day labor is not rendering competent service to the public. Too often the engineer who is insistent that the contractor comply rigidly with each and every provision of the specifications entirely overlooks the expensive features on day-labor work or makes modifications which greatly reduce the cost of construction. It is seldom that all of the items of cost are included in the statement submitted for public perusal. The work performed by the Water Board of Des Moines is a very good example of the effect that modifications have on the cost of the completed proj-

ect. A glance at the report of the county engineer for Van Buren county showing the cost of the 1923 bridge work would clearly demonstrate that he either had no knowledge as to the cost of the work, or deliberately manipulated figures to make a showing for his board. If you face the facts, the result is inevitable. Last week in an address at Washington, Secretary Hoover said he would like to see an investigation made to determine the relative cost of public construction by contract and day labor. Then he added: "It is my opinion, as an engineer, that the construction of public work by contract makes for public economy."

The foregoing paper by Mr. Crowley was presented before the recent annual meeting of the Iowa Engineering Society.

EXPERIENCE WITH STATE AID ROADS IN ILLINOIS

By A. B. Hurd, Superintendent of Woodford County Highways, El Paso, Ill.

State aid in Illinois, under the Meents Act, provides in part that public highways, or sections thereof, including bridges therein, may be laid out, improved or constructed at the joint expense of the State and any county within the State. The State shall contribute one-half of the expense, and the county or counties through which the said highway or portion thereof passes, shall contribute the remaining one-half. Such highways are hereinafter known as "State Aid Roads".

Some Provisions of the Act

The Board of Supervisors or County Commissioners of any county shall, by a majority of the entire board of supervisors or county commissioners, in regular or special session, specify the type of road to be constructed under the provisions of the Act in their respective counties.

At their next regular or special meeting following the passage of the Act it shall be the duty of the supervisors in counties under township organization, or the board of county commissioners in counties not under township organization, to designate those public highways within their respective counties that shall come under the provisions of that Act. The highways to be designated by the county boards shall be as nearly as possible those highways connecting the principal cities and trading points in each county with each other, and also with the principal cities and trading points in other counties.

The total mileage of such highways in any county shall not exceed in counties of the first class 20% of the total public road mileage of that county, nor more than 25% in counties of the second class, nor more than 30% in counties of the third class. Woodford county is in the first class and has about 900 miles of roads.

The Meents Act, which is an Act in relation to State Highways, provides in part: "All highways which have heretofore been or may hereafter be designated under Article IV, 'An act to Revise the Law in Relation to Roads and Bridges', as highways which may be laid out, improved or constructed at the joint expense of the State and any county within the State, or by any county of the State, until such time as the said highways are taken over * * * shall be under the direct control and supervision of the County Board of the county in which said roads are located, and the County Board shall improve, maintain, and repair by patrol system, or otherwise, said roads from county funds as levied herein."

"For the purpose of improving, maintaining, and repairing the highways required to be improved, maintained, and repaired by the county as provided in Section 12 of this Act * * * the county shall have the power to levy an annual tax to be known as 'County Highway Tax' * * * all money derived from the County Highway Tax to be placed in a separate fund to be known as 'County Highway Fund' and shall be used for no other purpose."

I will go back to 1917 for at that time our County Board elected to use the State Aid appropriations to construct graded earth roads. This was done because they felt the appropriation of 1915 which was used in building a concrete road did not give them sufficient mileage. This policy was continued until 1920 when all of the State Aid appropriations and other appropriations made by the county had been exhausted.

Having elected to build the graded earth road the county was by law, duty bound to maintain these roads. When the Meents Act became effective in July, 1921, the county was maintaining about

26 miles of State Aid dirt roads. Their maintenance equipment consisted of a few road drags and two government trucks. One was used for dragging the roads and one was equipped with a pressure oil distributor. The funds for carrying on this work were provided by annual appropriations from the county.

In Woodford County

At the September, 1921, meeting of the County Board the 25c County Highway Tax (the maximum tax provided under the Meents Act), was levied and a committee was appointed to formulate plans and policies to be adopted in the expenditure of the County Highway Tax and to report back to the board at the December meeting. This committee met with the County Superintendent of Highways and a portion of their report which was adopted follows:

(1). We recommend that all State Aid Roads that have been improved by county or county and State money be maintained by grading, dragging and oiling.

(2). Other State Aid Roads to be patroled and oiled by the county after they are properly graded and approved by the County Superintendent of Highways.

(3). All State Aid Roads to be systematically patroled with drags during the season of the year that this can be done with motor power.

(4). New graded sections of State Aid Roads to be built as money available will permit. Roads to be graded to meet the State's standard 24 ft. cross section. Such cuts and fills to be made, as in the opinion of the engineer, are necessary to produce a good road.

(5). All drainage structures to be designed to meet the State Highway Specifications. All cross road structures to be built at the joint expenses of county and township in which the bridge is located, each paying 50% of the total cost.

(6). The minimum width of right of way on all State Aid Roads shall be not less than 50 ft. Where this width does not exist it shall be procured at the expense of the township through which the roads pass prior to the starting of construction.

All right angle turns and all intersections of State Aid Roads shall be built on a curve having a 300 ft. radius. Exceptions to this rule will be made where it is not possible to secure a curve with this radius, such as passing through cities or by a residence.

(7). That all money expended annually in new construction be expended on the following roads in the order named. The roads to be improved and the order of improvement was made a matter of record.

(9). We recommend the purchase of the necessary grading and maintaining machinery to grade and maintain these roads.

Recommendations Explained.

A few words in explanation of some of the paragraphs in the foregoing recommendations.

Paragraph No. 2 provided for the proper maintenance of other roads as they were added to the *first class* system.

Paragraph No. 3. The Meents Act provided that the entire system of State Aid Roads should be improved. Paragraph No. 3 provided that the county would keep the second class roads smooth and passable during the season of the year when it could be done with motor power (Summer months). Many of these roads were so flat, that they did not feel much benefit would be obtained from winter dragging as they would not dry out if they were dragged.

Paragraph No. 4 provided that other roads should be added to *first class* roads as fast as the money was available for building them. Surveys were made of the roads to be added, plans prepared, and each year we have added to the system a few miles of well-graded roads, particular attention being paid to an alignment that would provide good vision and a maximum grade of 4%. We expend annually about 25% of our County Highway Tax for new construction.

Paragraph No. 5 provided that all bridges must meet the State Highway Department's Specifications and this required the rebuilding of many bridges. Most of them had narrow roadways which are very dangerous to traffic on a well-graded road.

Paragraph No. 9. An appropriation of $10,000 was made for the purchase of machinery. The equipment purchased consisted of a large tractor and grader, a multiple blade maintainer, slips, drags, and also five trucks rented from the State. Other machines have been added from year to year.

At present the county has one 10-ton, one 5-ton, and two 2-ton Holt Tractors; one 12 ft. and one 8 ft. grader, 3 multiple blade maintainers, elevating grader, wagons, wheelers, ploughs, slips, and drags.

The State trucks were used for dragging and light maintaining. They gave fairly good service on the first class roads, but soon went to pieces when used on the second class roads. We have discontinued using trucks for tractive power and are now using small tractors of the "Caterpillar" type. We prefer the separate units to the motor-driven maintainers because we are able to use the tractor for many other purposes. We carry a slip scraper on our multiple blade maintainers in the Spring of the year and when we find holes that require slip work the tractor is unhitched from the maintainer and used as power in pulling the scraper. We can generally fill in these places in a few hours time and go on with the maintaining. In the Fall of the year when the maintenance is not so heavy the small tractors are used on a slip scraper to fill in around bridges and culverts on the new grading. We find the tractor more efficient than teams and our men prefer to handle the slip with tractor power because it moves more steadily than teams. These tractors will travel any place a team will go and many places where teams will not go.

Our Present Equipment

The 10-ton Holt tractor is used in pulling a 12 ft. blade grader equipped with a back sloper. It is also used to pull an elevating grader when cutting down hills or making fills.

A 5-ton Holt tractor is used for light grading or heavy maintaining, also in pulling Roy Trac scrapers in cutting down hills, or making fills around bridges. The Roy Trac scraper is a large wheeled scraper holding ¾ yd. of dirt. We pull four in tandem with the 5-ton tractor.

All of our tractors are used in maintaining our first class roads in the Spring of the year. All ditches are cleaned and surface put in shape for oiling. After this is done the secondary roads are smoothed up. This generally takes until the last of June. Our equipment is then placed on the new grading sections, except the smaller equipment which alternates between the maintaining and new grading as conditions require.

At present we have 60 miles of *first class roads* and expect to add about 10 miles to this system in 1925. Our plans call for the oiling of these roads as fast as they are improved. As our mileage increases the annual cost of road oil increases and unless some other method of financing is provided the money available for new construction will gradually diminish.

My policy has been that all money levied and collected for highway purposes, whether by county, township or road district should be wisely expended annually in the building of some road improvement and not permitted to accumulate in the hands of the treasurer of such fund.

I make an annual budget of the amounts needed for patroling our first class roads; road oil for same, the dragging of the entire system, the new bridges and new grading, and present it to the finance committee before the September levy is made. As a result we generally levy the limit as our county is sold on the first class roads and want them built as fast as possible.

The financing of this construction and maintenance work is our most difficult problem. The people feel that the money should buy more miles of road. The 25c tax does not provide sufficient funds to build these roads as fast as the public demands. And yet at this season of the year when the tax collector is sending out his statement of the amount of taxes due, we realize that the combined road tax and other taxes is considerable.

After working four years under the Meents Act, I believe we can all say that we like it. It has given the County Superintendent a *fund* to work with and an opportunity to show his ingenuity.

The foregoing paper by Mr. Hurd was presented before the recent Short Course in Highway Engineering held at the University of Illinois at Urbana.

METHODS AND POLICIES OF PREVENTING STREAM POLLUTION

By H. V. Pedersón, State Sanitary Engineer, Des Moines, Iowa.

Every national or state-wide movement, which affects the general public, must be worked out along some definite plan if it is to be successful. There have been very few movements of any

consequence which did not at first create a wide variation of personal opinion, which difference of opinion had to be ironed out before any real progress could be made. A definite policy had to be adopted, and strictly adhered to in spite of individual opinions.

The prevention of stream pollution is a relative new state-wide movement in Iowa, and like other movements in the past, it is also accompanied with a variation of opinion. The difference of opinion is not that any one is definitely opposed to the movement but rather a difference as to the policy of procedure to bring about desired results. Before any real progress can be made all parties must agree, adopt some definite policy and work together to bring about the desired results.

Two Distinct Policies

At the present time, there are two distinct policies to bring about the prevention of stream pollution. The first policy is that of controlling the amount of organic waste matter that can be discharged into a stream at any particular point, and keeping the quality of the water within a certain degree of purity, which degree of purity is to be determined only after a sanitary survey has been made. The other policy is to ignore actual facts entirely and in a sweeping manner prohibit everyone from discharging any amount of organic matter into any river at any point.

A Liberal Policy

At first thought, there may not seem to be a great deal of difference between these two policies, but the more one studies them, the wider the breach becomes. The one policy aims to take all of the controlling factors into account and no final decisions will be made except those based on fact. The other policy would be that of disregarding facts, and, right or wrong, demand drastic regulations. A thorough study of the Iowa Rivers which should be made, if the more liberal policy is adopted, would include a study of riparian rights, of damages sustained to farmers living along the river bank, of the potential sources of danger to the public health and the extent to which pollution has affected recreational pursuits. Such a study should be made with one chief thought or aim in mind. Namely, that of attempting to work out in an intelligent, scientific way, a solution to the stream pollution problem that will bring about maximum benefits to the majority of the people of the State.

A Drastic Policy

A drastic policy would doubtlessly bring about quicker results in specific cases where conditions have become acute, but such a drastic state policy would tend to arouse the industries and certain communities to anger and cause them to put on their fighting clothes. Then, too, an attempt to enforce a drastic policy would give rise to many arguments and disputes, which could not be settled outside of court. For instance, a certain industry is discharging a waste into a river and is notified to cease from this practice after a certain date. The industry refuses to obey the order on the ground that it is not discharging a waste containing either poisonous substance or an appreciable amount of organic matter, which affects in any way the conditions of the water of the river. If the industry is right in its assumptions, then a grave injustice has been done it. If it is wrong, the State or any other agency would be compelled to make detailed studies before it could actually prove it in court.

There are in the State, approximately 291 cities that are provided with sewerage systems for the disposal of domestic wastes. Out of this total number, 185 are also provided with sewage treatment plants for the purification of the wastes. Eleven cities are located on the border rivers, leaving a total of 95 cities discharging sewage directly into the rivers within the State. The total population of these cities discharging sewage direct is 782,136 as compared with 320,127 or the population of communities having sewage treatment plants.

Iowa Rivers

The Des Moines River Valley has a drainage area of 14,300 square miles and there is a total population of 615,000 on this area. Forty-three cities having a total population of 68,000 have sewage treatment plants against 23 cities having a total population of 226,000 discharges sewage directly into the river. It has been roughly estimated that the very least possible cost of constructing all of the municipal sewage treatment plants in the Des Moines drainage area will be not less than $4,500,000.

In the Cedar and Iowa River Valleys there is a combined drainage area of 12,600 square miles with a total popula-

tion of 550,000. Twenty-nine cities having a total population of 67,000 have sewage treatment plants, while 14 cities having a total population of 106,000 discharge sewage directly into the river. It has been estimated that it will cost at least $3,000,000 to construct the sewage treatment plants in these two river valleys.

The Nishnobotna River in the southwest part of the State has a drainage area of 3,200 square miles. Located on the area are 15 cities discharging sewage directly against five cities that have treatment plants. It is estimated that the cost of installing the treatment plants in this valley will be close to one-half million dollars.

Industrial Wastes

There are nine industries that contribute industrial wastes into the rivers flowing through Iowa at the present time. Out of these nine, five are packing plants, two are beet sugar plants, one corn produce plant and one paper box plant. Two of these plants are located on Lime Creek, which discharges into the Shell Rock River, which in turn, discharges into the Cedar River. Three are located directly on the bank of the Cedar River. Two are located on the Des Moines River, and two on the Iowa River. These industrial wastes tend to make conditions more acute in their particular locations, but taken as a whole, the amount of industrial waste is small as compared to the domestic waste. The cost of industrial treatment plant for each of these industries, will be from $50,000 to $75,000 or even more, depending upon the nature of the waste, or in round figures, a probable total cost of $650,000.

This gives some idea of the scope of the stream pollution problem. Practically every river of any size is affected to some extent, although as it seems reasonable to expect, the larger the river the larger the problem. The one thing to keep in mind is that the problem of the prevention of stream pollution is not merely a local affair here and there, but that it is a State-wide problem and one that is growing more acute and more serious year by year.

Facts Needed

To try to handle this State-wide problem, which will involve over $10,000,000, in a narrow-minded, drastic way, would be to excite a great deal of unnecessary litigation. The first question that will arise is: Is it really necessary as a public health measure, to compel every city or town in the State irrespective of its location, to cease from discharging sewage into a river? If the facts are not known, how is one to know just where to start or where to stop? Or how can one town be excused and another ordered to comply with the pollution law? If it is not necessary from every angle viewed, for a town to install a sewage treatment plant, then it would be a gross injustice to compel it to do so. But the moment any town is excused before the State Department has the facts upon which to base its decisions, every other town will expect to be placed in the favored class.

Conservatism Advised

Every engineer in the State should be interested in this problem in the prevention of stream pollution. If he can see no definite connection or application to his particular branch of engineering, every engineer should be interested at least as a citizen of the State. As an engineer, he should realize and appreciate, best of all, the need of basic facts and be willing to make this point clear to the people of the community in which he lives. Sanitary engineering is no different than other branches of engineering, and if it is essential for a designing engineer to have all the facts regarding earth strata, etc., before he can design a suitable and safe foundation for a bridge or some other structure, it is just as essential for the sanitary engineer to have all of the facts in regard to the condition of the rivers before he can come to any logical and definite conclusion. No matter what he undertakes, the engineer is expected to take every item into consideration to lessen the cost and the engineer should hesitate to accept a state policy in regard to stream pollution that will tend to work an economic hardship when a policy can be adopted that will secure the same ultimate results with less drastic action or less hardship.

The problem before us at this time is, what policy should Iowa adopt regarding the prevention of stream pollution, and who is to formulate this policy? As this is a problem which involves engineering, it seems to me that the opinions of the engineers of the State would have a great deal of weight in formulating such a policy. For this reason, we wish to suggest that a committee be appointed of not less than seven

members to consider the stream pollution problem of the State, and to draft up a definite policy, which it believes to be the best policy for the State as a whole to adopt as regarding the handling of this most important and intricate problem.

The foregoing paper by Mr. Pedersen was presented at the 1925 meeting of the Iowa Engineering Society.

WORK OF THE TESTING BUREAU OF THE ILLINOIS HIGHWAY DEPARTMENT

By H. F. Clemmer, Engineer of Materials, Illinois Division of Highways, 100 E. Washington St., Springfield, Ill.

Insuring the quality of state pavements by comprehensive specifications and thorough inspection of all materials has been recognized in Illinois as a necessary policy in the extensive construction program made possible by the availability, during the past few years, of over $160,000,000 for this purpose. In accordance with this policy the Bureau of Materials has grown to be one of the most active sub-departments of the Illinois Division of Highways and has not only had in charge the inspection of all materials but in addition, the supervision of investigational projects concerned with problems of design, construction and maintenance.

Help for Counties and Townships

In furthering the state-wide use of tested materials the Bureau now offers inspection, free of charge, on all highway materials purchased by county and township organizations in the State with the exception of those used by municipalities.

Materials inspected include stone, gravel, sand, cement, brick, lumber, paint, asphalt, tar, road oil and reinforcing steel. Tests on lubricating oils and gasoline are also made for the machinery department of the highway division.

Plant Inspection

By placing inspectors at the various producing plants, it is possible to make inspection on all materials at the source. Plant inspection under this policy has proved to be an important factor in construction progress eliminating inconvenience and extra costs occasioned by rejection at destination with subsequent demurrage or reshipping charges and, for this reason, enjoys both the approval and cooperation of material producers, contractors and state highway engineers. District testing engineers, assigned to each of the nine state highway districts, have direct charge of the inspection of all materials in their respective districts and cooperate with the producer and contractor in securing the best results.

Magnitude of Operations

An indication of the magnitude of the inspection activities of this Bureau is given in the fact that more than 125 inspectors were placed at 150 plants fur-

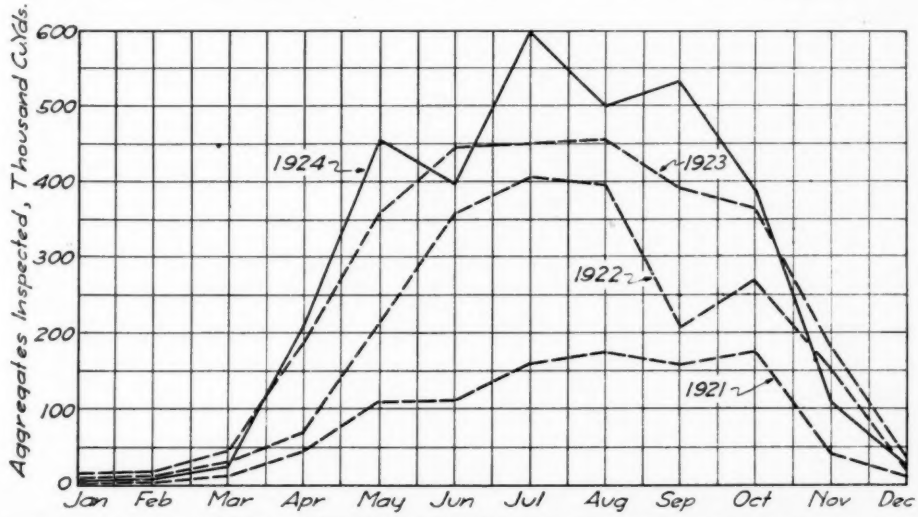


FIG. 1—CHART SHOWING AGGREGATE INSPECTION BY MONTHS FROM 1921 TO 1924.

nishing materials during the past construction season. In the construction of over 1,200 miles of concrete roads during the past year, it was necessary to utilize sources outside of the state so that inspectors were also maintained at materials plants in Wisconsin, Iowa, Indiana, Kansas, Missouri and Arkansas. Approximately 4,500,000 barrels of cement, 3,250,000 cu. yds. of aggregates and 43,000,000 lbs. of steel were inspected during the past season.

As an illustration of the yearly increase in quantities of materials inspected. Figure 1 shows the amounts of fine and coarse aggregate tested for each of the past four years. Quantities of other materials vary in like proportion.

Oil Inspection

Although not directly in charge of the improvement of earth roads by oiling methods, the Bureau of Materials offers inspection service on all materials used by counties or townships for that purpose. Chemists stationed at each of the refineries that furnish large quantities of oil for county road work make all tests on the material before shipment. Approximately 42,000,000 gals. of road oil were inspected during the past year.

Cost of Inspection

From records obtainable during the past few years the cost of inspection of all materials has been shown to be less than 7/10 of one per cent based on total construction cost. This is an interesting item for comparison, refutes any statement regarding the fallacy of inspection due to cost, and may be considered an extremely low premium for the insurance on quality that is assured.

Examples of the disastrous result of poor materials are many and are well known to the engineer. Distintegration in various forms will inevitably result from the presence of clay balls, straw, ochre, coal, iron ores or other impurties in sand and stone or from unsoundness of cement. Rigid inspection dismisses the possibility of occurrences such as mentioned and is heartily and permanently endorsed by all parties concerned with the construction as well as the use of paved highways.

Investigation and research under direction of the Illinois Bureau of Materials supplements the routine inspection of materials in determining not only the conformity to specified properties but goes further in dealing with the practices and materials that will develop the best concrete. Specifications and practices now in force are largely the result of investigations conducted for the purpose of examining into the theoretical soundness of these methods.

The Bates Road Experiments

Previous to the construction of the Bates Experimental Road no extensive investigations in Illinois had been made. Passage and ratification of a bond issue providing for thousands of miles of concrete pavement created the necessity for determining the best possible methods of constructing this extensive system or in short, "prove the way". Accordingly, 68 types of pavement were constructed end to end to form what became universally known as the Bates Experimental Road. These sections were tested and observed for their reaction to every factor of climatic condition and traffic severity. As a result of these tests there was developed the present Illinois Standard Design of pavement slab which has proved to be more than equal to this state's present legal traffic loads and which in Illinois alone saved, in cost of construction during a period of two years, over 20 times the total cost of the Bates Road itself. This was one of the most gigantic highway research projects ever attempted and is a most successful example of the value of investigation and research in highway fields.

The Bureau of Materials was in direct charge of all investigational work on this project. In the intervals when traffic tests were not being made experiments were conducted and data assembled on stresses in pavement slabs due to impact, static and moving loads, warping and other movements in slabs due to varying temperature and moisture conditions, moisture content and bearing power of subgrade soils as well as many other determinations of equal interest and importance.

Fatigue of Concrete

For the past four years an investigation on "fatigue" of concrete has been conducted, results of which have also been considered in the adoption of the new design. The test was suggested by the hypothesis that concrete has an endurance limit under definite intensities of load and will fail by "fatigue" on repeated applications of a load not sufficient to cause failure in one application. Results obtained in the testing of several hundred specimens have indicated that concrete does "fatigue" and that its endurance limit under repeated load is approximately 50% of the load which

would cause failure in one application. Investigations of a similar nature by other agencies have checked closely these results. Other considerations such as recovery during rest periods and rate of application of load reduce the possibility of any extreme condition of fatigue in a pavement slab. The present standard design, however, makes allowance for such an extreme condition by providing a safety factor.

Curing Concrete

Another investigation that has paid dividends in practical application of its results is one which dealt with the value of various methods for curing concrete. This series of experiments included the testing of over 2,000 concrete specimens cured by several methods and has led to the use of calcium chloride as a curing agent for pavements. As a direct result of this investigation over 1,500 miles of concrete pavements have been treated in this manner in Illinois alone. A number of other state highway departments have lately adopted this method of curing.

Core Drill Testing

Under the direction of the Bureau of Materials two core drills, mounted on trucks, are assigned to travel over sections of finished pavement for the purpose of drilling test specimens and measuring the thickness of the slab. Specimens are identified by the drill operator and shipped to the main laboratory where they are examined for depth, porosity, unit weight and general quality, and then tested for compressive strength. Precast concrete cores are in turn furnished by the laboratory to refill the holes made in the pavement by the drilling operation. A complete log of the results of these tests is maintained at the main laboratory both for present use and for the possibility of future reference. Analysis of results also furnishes interesting and valuable record of field strengths on concrete.

The Profilometer

A second instrument for the testing of quality of finished pavements, designed, constructed and operated under direction of this Bureau is the profilometer, previously described in several papers and technical journals and now finding valuable application in the examination of pavements for smoothness of surface. Two models, one having 16 wheels, and the other 32, have been operated for test purposes during the past year over several sections of concrete pavement in various parts of the state. Surface smoothness, a not altogether necessary refinement in pavement construction but a quality that establishes public approval of the work, has been emphasized by the Illinois Highway Division for many years. Specifications now allow no greater than ¼ in. variation in 10 ft. on the surface and provide suitable penalties or provisions for removal of any irregularities found. Work with the profilometer and similar machines is being continued in an effort to secure smoother pavement surface.

Concrete Mixtures

One of the most important studies which has occupied the attention of many laboratories throughout the world is that concerned with the design of concrete mixtures. Under this classification may be included investigations of the effect on strength of concrete, at various ages, of the type, physical properties and gradation of fine and coarse aggregates, methods of proportioning, quality of cement, water-cement ratio and mixing period. The investigations in these problems, made by the Illinois Bureau of Materials, have been by the use of the 1:2:3½ volumetric mix, standard of this department for highway work.

Elastic Properties of Concrete

A second group of studies to which this Bureau has also given considerable attention are those relating to the elastic properties of concrete. Coming under this classification are those investigations and experiments made to determine for various qualities and ages of finished concrete such values as modulus of elasticity, modulus of rupture in flexural tests, strength in compression, coefficient of expansion and the correlation of all these data, having in mind the establishment of definite values for these properties on which future design may be based. Many original and valuable methods and apparatus have been developed in these experiments.

Included in the problems not closely associated with the design of pavements or the properties of concrete, but nevertheless an important phase of investigation is the survey of typical subgrade soils and the determination of their properties that would affect the supporting power or other structural features in connection with the design of pavement slab, bridges or culverts.

Under this miscellaneous classification also may be mentioned experiments on road oils, paints, cements, asphalt and reinforcing steel. By both practical and scientific tests many of these materials have been under observation for suitability for use in or on the pavements and highway structures in Illinois.

Investigational projects and researches do not, in the majority of cases, pay immediate dividends. Stated otherwise, results of experiments bearing on any certain problem do not always settle at once questions arising in this problem. Tests must be made and checked and thorough examination made of all angles to a problem before results may be given out for practical use. The Bureau of Materials in Illinois has, however, been fortunate in carrying to completion and enjoying valuable practical application of many of the investigations conducted under its supervision. Cooperation with the committees of national and state technical societies has broadened the work and given results an outlet for the use of the entire world and the benefit in general of the whole engineering profession.

The foregoing paper by Mr. Clemmer was presented at the 1925 meeting of the Illinois Society of Engineers.

AESTHETIC TREATMENT OF DRAINAGE SPOIL BANKS

By Milo C. Taylor, of Taylor & Woltman, Civil Engineers, Bloomington, Ill.

While the title of this paper would indicate a very broad subject, this discussion of it deals with but one specific instance of where the spoil banks of a dredged channel received somewhat unusual aesthetic treatment to meet a particular and unusual condition.

Ugly Banks an Obstacle to Improvements

It is not claimed that this procedure with its attendant expense would be warranted in the average farm drainage district project, but the obstacle of unsightly appearance of spoil banks has no doubt confronted every drainage engineer engaged in the organization of drainage districts, at least in partially developed territory, and this contribution is made for what it may be worth towards the solution of this difficulty.

A Specific Example

The project which forms the basis of this paper is the open channel of the Bloomington and Normal Sanitary District. This dredging operation was unusual in that the major part of it was through a settled residential section of a city. The high character of the district may be judged from the fact that there were four boulevard crossings, nine other street crossings, three railroad crossings, and four street car crossings in the relatively short length of 2½ miles.

From the beginning it was realized that the spoil banks would require special handling to avoid unsightly appearance in the residential section. Accordingly the specifications carried a somewhat general clause requiring that spoil be deposited in approximately equal portions on each side, and be built up to definite cross section with flat top and uniform specified bottom width at a plane 7 ft. above the grade of the channel, the whole to be dressed with hand tools to a smooth surface which would permit seeding or sodding.

Smoothing Banks

A very satisfactory surface was obtained in this way and the cross section obtained was sufficiently good to have made a good job of seeding possible. However, due to the unevenness of the excavated material longitudinally, particularly near street crossings where huge piles accumulated from the excavated material of the streets, which, it was specified, should be placed entirely outside the street area, it was deemed advisable to even up the banks longitudinally between street crossings.

This work was undertaken with teams on a force account basis. A good grade man was secured who, with supervision by the engineers, was able to obtain a very even distribution of dirt longitudinally in the short distances between streets by cut and try methods, rather than by cross sectioning the banks, calculating the yardage, balancing cuts and fills, and staking a grade.

Some gravel was encountered in the excavation, but, in general, a slightly sandy loam and clay prevailed which worked up easily and possessed sufficient stability to withstand wash from rains.

Seeding

The dredging operation was completed in the winter of 1922-23 and the following season the banks on about half the length of the improvement were graded down as above, and in August of that year were seeded to alfalfa. This

plan was carried out upon the advice and under the supervision of an expert agriculturist engaged for the work. Soil tests were made revealing absolute absence of acidity, a necessary condition for alfalfa cropping, due to the presence of considerable natural limestone in the excavated material.

A perfect stand of alfalfa was obtained and the results were so gratifying that in 1924 the balance was treated in the same manner. The transformation effected by this procedure needs to be seen to be fully appreciated. Unsightly, uneven piles of dirt strewn along a dredged channel with berm and bank overgrown with rank weeds, scrub brush, etc., replaced with uniform banks reduced in height, following the straight lines and graceful curves of the straightened channel, the whole clothed in a coat of verdant green, produces a sight beautiful to behold, in appearance more like a narrow strip of park, a pleasure to look upon.

Economic Advantage Secured

In this particular case the expenditure of money for such a purpose has proved of economic advantage as well to the trustees of the Sanitary District. On that portion of the work done in 1923 the total expenditure for leveling down the banks and seeding the same, including the agriculturist and engineer's fees, was $4,175. Interest on this at 6 per cent amounts to $250 per year. For the season of 1924 a contract was made whereby the alfalfa crop was cut and removed from the right of way, all weeds kept down in the fence rows and ditch banks, with a net cash return of $45 to the Sanitary District. The balance of the interest charge, $205, would not have been sufficient to keep the weeds mowed through the season on the untreated banks, to say nothing of the aesthetic considerations. By proper supervision of the cutting, the agriculturist states that the results obtained in seeding may be considered reasonably permanent.

The 1924 work cost $3,900 including the fee of the agriculturist and engineers, making a total expenditure of $8,075 on the whole project for additional work on the spoil banks after the dredging machine left the job. This does not take account of the extra cost of shaping the spoil banks by the dredging machine, which cost is hidden in the price bid for excavation, but I am informed by the contractor that only a very nominal allowance was made for this, and a part of this work was lost in the subsequent operations.

The total length of channel upon which the spoil banks were treated was 12,400 lin. ft. Deducting for street crossings, etc., the banks cover about 11,500 lin. ft. on each side, or a total of 23,000 lin. ft., a price of 35c per lin. ft. for a single bank. This is equivalent to $3,700 per mile for both banks on a similar sized channel. In this case the aesthetic treatment constituted about a 36 per cent addition to the dredging contract.

The present alfalfa area is about 19 acres. Considering this as otherwise useless land redeemed for crop purposes, it constitutes an expenditure of $425 per acre, rather an extravagant price, you say, for even good agricultural land, but when one considers its aesthetic value to a farm, and its consequent reflection in value to the balance of the farm of which it forms a part, may it not contain possibilities to make it worthy of some further study and consideration by drainage engineers?

The foregoing paper by Mr. Taylor was read at the 1925 meeting of the Illinois Society of Engineers.

IMPORTANT FEATURES OF CONCRETE PAVEMENT CONSTRUCTION

By Col. H. C. Boyden, Portland Cement Association, 111 W. Washington St., Chicago, Ill.

A discussion of concrete pavements may conveniently be divided into three phases:

1. Quality of the concrete.
2. Design of the section.
3. Construction methods.

All three of these phases are interdependent and a failure to follow proper procedure in one phase may offset all the good obtained by careful attention to the remaining details.

Quality of Concrete

High quality concrete is essential for all types of concrete structures, but especially so for pavements, in order that they may successfully resist the severe treatment and rough usage to which they are subjected by the traffic of today. Concrete pavements have been built in the past of a weak mixture as low as 1:2½:5, but experience has

taught that a higher quality concrete is absolutely necessary.

The quality has gradually improved until at the present time the most common mixture is 1:2:3 or 1:1½:3, giving an average compressive strength at twenty-eight days (when properly made) of from 3,000 to 4,000 pounds per square inch.

As our knowledge of the factors entering into the design of concrete pavement slabs increases, the tendency is toward the requirements of a concrete of a definite compressive strength. This tendency has not reached the final stage of a strength specification, but mixtures are being designed, slumps are being specified, and daily tests are being made to insure the desired strength.

It is obvious that uniformity of strength and wear resistance in all portions of a pavement are very necessary in order to have a lasting pavement. Having decided upon the strength quality of the concrete (and it should not be under 3,000 lbs. per sq. in.), every effort should be made to keep the concrete within a reasonable range of this figure. It is not economy to run much above the designed figure and it invites failure to run below it.

Having designed (by methods that are now available to all) a mixture from the actual materials that are to be used on the work, attention should be given to insuring that the resultant concrete is uniformly of the designed quality.

In the choice of aggregate, well-known rules should be followed, but at the same time tests should be made of local materials that might ordinarily be rejected, to see whether they will not give satisfactory results. A number of conclusions drawn by the Bureau of Public Roads, as a result of their recently completed wear tests, are of interest in this connection, for example: "That rubber-tired traffic alone does not appreciably abrade the surface of a concrete pavement."

Remember that this statement covers all the classes of concrete—good, bad and indifferent—which were used in the sixty-two concrete test sections; therefore, the consideration of wear is of importance only when considered in conjunction with the concentration of rubber tires with skid chains or of steel shod wheels. These conditions only occur in certain locations. The results of the Arlington tests have again emphasized the care that should be taken in the selection of sands. The "Colorimetric Test for Organic Impurities" should always be made. The tests also indicate that the coarser, well-graded sands give the most wear resistant concrete.

Quality of Coarse Aggregate

Several conclusions bearing upon the quality of the coarse aggregate are of interest:

1. "That the rate of wear of stone concrete is, in general, not affected by the coarse aggregate, provided the coarse aggregate is equal or superior to the mortar matrix in resistance to wear."

2. "That excessive wear will result from the use of very soft stone as coarse aggregate, even though used in conjunction with a mortar of satisfactory quality. From the results of these comparative tests, it would appear that stone with a percentage of wear over 7 (French co-efficient 5.7) should not be used in concrete road construction."

5. "That gravels consisting of rounded particles are as satisfactory from standpoint of wear as those consisting either wholly or in part of angular or crushed fragments."

Conclusion No. 18 bears upon the effect of cement content:

"That so far as resistance to wear alone is concerned, increasing the cement content beyond a cement-sand ratio of 1:2 does not materially affect the concrete. Leaner mixes on the other hand show marked increase in wear."

Conclusions drawn regarding the relation between the quality of the concrete, as shown by its compressive strength and laboratory wear tests, and the relative wear under the conditions of these tests indicate different results from those found in previous studies by other investigators.

In spite of these apparent differences, general experience has shown that compression tests have generally given a very good index of the wear resistance qualities of concrete in pavements and, as will be shown later, such tests are of great value.

Moisture Content in Aggregate

As stated before, much emphasis should be placed upon obtaining a uniform concrete in the pavement, and there is one factor in construction that is productive of non-uniformity, which is being overlooked in much of our construction today.

This factor is the effect upon the quality of the concrete caused by the variation in the moisture content of the sand and stone or pebbles.

Having chosen our ingredients and having designed our mixture to give us a desired strength at a certain plasticity, or having fixed upon an emperical mixture, we must then concentrate upon insuring that each batch of concrete shall have the same qualities.

The basic requirements for uniformity in concrete are a *uniform water-cement ratio,* a *uniform number of grains of sand* and a uniform number of particles of stone or pebbles in each batch.

All designed concrete mixtures are based upon a mixture of cement and water in proper ratio to each other, with *dry rodded* sand and stone or pebbles. With this fact in mind, it is very evident that the variable amount of moisture found in sand and pebbles during construction must cause a variation in the quality of the concrete.

Experiments at the Bureau of Standards and in other places have shown that moisture in sands will cause a certain amount of bulking in volume, varying from a small percentage up to as high as 38 or 40 per cent. In the average sand from 3 to 5 per cent by weight of moisture will cause the maximum amount of bulking and they will drain at 8 or 9 per cent. The effect of moisture upon the volume of pebbles and broken stone is very small and may often be neglected, but the moisture itself must be taken into account.

Dry sand and pebbles measured loose will show an increase in volume for a given weight of from 5 to 6 per cent above the dry rodded volume. Therefore, from the above remarks, if we are to obtain a uniform output from our mixer, all of these differences, due to varying moisture content and field methods of measuring aggregates, must be accounted for.

The "Inundation Method"

A recent set of tests at the Bureau of Standards indicate that the most accurate method of measuring sand, regardless of its moisture content, is to pour or shovel the sand *into* water. This automatically eliminates the necessity for moisture and bulking determinations and is the basis of a comparatively new method of proportioning concrete, called the "Inundation Method."

Although this method is new, it has been used with marked success in several places and it has much to be said in its favor. It is anticipated that apparatus for use in this method will soon be placed on the market by the Blaw-Knox Company of Pittsburgh, and this will undoubtedly lead to a more general adoption of the method.

Another method of proportioning, which is a marked improvement over the usual volumetric method, is receiving considerable attention at the present time. This method involves the weighing of all ingredients and permits the proper adjustment of differences due to varying moisture content, but it still requires the determination of the actual amount of water contained in the aggregates, if the most accurate and uniform results are to be obtained.

The State of Iowa requires that this method be used on all state highway work, and it has been used in several other places in this country. Several of the large manufacturers of scales have devised weighing apparatus suitable for such operations.

However, whether the proportioning is by volume, weight or inundation, the factors mentioned above must be considered in the producing of uniform concrete.

There are, of course, many other factors that are of importance, such as uniform qualities and grading of aggregates, time of mixing, methods of placing and handling and uniform curing, but all of these have been emphasized many times and should not need repetition.

Design of the Section

In a discussion of the second phase, "The Design of the Section," we can draw much from the results of the test roads, but at the same time we can not consider the problem to have been entirely solved.

The problem, the solution of which has been sought for many years, is how to design a concrete slab to carry a given load with all conditions of subgrade and in all climates. This problem is not possible of solution by means of definite formulae today, but the test roads and experiments have shown us many of the factors entering into the design, and we are much better equipped than we were a few years ago.

One of the most radical changes from past ideas has been the changing of the thickest part of the slab from the center to the edges of the pavement. This idea, first put in practice by Maricopa County, Arizona, in the building of its concrete highway system, has proved to be effective in all of the road tests, in preventing corner breaks.

These corner breaks, which have occurred in pavements of uniform section and particularly in those pavements with edges thinner than the center, have been the cause of much expense and annoyance, as they have occurred not only at expansion joints but at cracks caused by shrinkage. When these breaks have occurred, continued traffic has often tended to cause them to progress over considerable areas.

So favorably has this idea been received by the engineers in the United States that over thirty states use the modified sections. As much county work follows the state standards, this shows a wide-spread adoption of this new idea.

The average thickening at the edges is three inches greater than the center thickness, which is generally uniform, running from six to eight inches and extending to within two feet of the edges. A few states have adopted a double curve section, not parallel, but giving greater thickness at the edges.

The State of Illinois, based upon the results of the Bates road test, is placing a continuous ¾-inch round bar in the thickened edges, but this idea is not so generally accepted among other states.

Longitudinal Center Joint

Another new development is the use of a longitudinal center joint in pavements eighteen feet or over in width, and eleven states are using this form of construction to a greater or lesser extent. This joint is placed during construction with the idea of overcoming the curling of the slab, due to uneven heating and cooling of the slab from atmospheric temperature changes. This curling, which was apparent at all of the tests, is often sufficient to lift the edges of the slab free from the subgrade during the cool nights and the center during the heat of the day. This naturally puts great strains upon the center of the slab and may often be the cause of longitudinal cracks.

There are a number of methods of constructing this joint, varying from a plain vertical cut to keyed joints of various shapes made with metal forms which are left in the road surface. Illinois ties the two sections together with ½ in. by 4 ft. deformed bars placed 5 ft. c. to c., and a number of other states have followed this practice.

This center joint has assisted in developing the practice of painting a black (or sometimes a white) line at the joint, to warn traffic of the danger from getting on the wrong side of the road. Many highways are thus marked (one state going so far as to build permanent white cement dividing strips on all curves), and this idea is meeting with general approval by the traveler on the highways.

This type of construction also lends itself favorably to the building of the surface at two different times, when such a program may be advisable through a lack of finances for full width construction or in such localities where detour roads are expensive or impossible.

The practice of dividing the highway into sections of various lengths by use of transverse expansion joints still remains a matter of difference among highway engineers, but the tendency is generally away from the use of such joints in the building of rural highways. The opposite, however, is true regarding city streets and it is believed advisable to use expansion joints in constructing them.

Reinforcement

The same differences of opinion are found in deciding upon whether to use reinforcement in concrete pavements, as it is used in some states and not in others. Owing to the slight additional beam strength given to a thin slab by the placing of a reasonable amount of reinforcement, and to the fact that the stresses change from top to bottom, or the reverse, as conditions of loading change, the desired effect can only be gained by placing reinforcement in both top and bottom. This would require an excessive expenditure, which would produce much more strength by being expended for a thicker slab.

An inspection, however, of both reinforced and unreinforced highways that have been under traffic for some years indicates that the advantages gained by the use of a reasonable amount of reinforcement, in the way of

preventing cracks and of holding together cracked slabs, warrants its use.

The tests and experience also indicate marked advantages gained by the use of special reinforcement placed at the weakest points, such as at corners and edges, and this idea is being followed out in many localities.

High Test Concrete

Much additional strength can also be gained by the use of high compressive strength concrete, as this quality, together with high tensile strength, is a factor in beam strength. Although the two qualities are not parallel, it has been proven that concrete having high compressive strength also has much higher tensile strength than does that having low compressive strength. This is an additional reason, to the one given in the discussion of the wearing qualities of concrete, for the use of compression tests for judging of the quality and uniformity of concrete in highway construction.

Width of Pavement

In the United States particularly the enormous increase in motor traffic, in the vicinity of and between centers of large population, has made the generally adopted width of highways of eighteen feet not only too narrow from the point of comfort, but actually dangerous during the periods of maximum travel. An analysis of traffic accidents shows a very considerable percentage occurring on straight roads, due principally to attempts of drivers to pass ahead when the traffic is running in two closely following processions.

This is one of the reasons why there is an endeavor in many states to build wider roads wherever there is sufficient traffic in prospect to warrant it. A twenty-foot width for two-way traffic is much safer and it also permits more rapid traveling during congested periods, thereby enabling the pavement to handle a greater volume of business.

In addition to the above reason for the adoption of the twenty-foot width is the fact that the Bates road tests very clearly demonstrated that the life of the pavement is vastly increased by keeping traffic further from the edges than is possible on an eighteen-foot width. On one side of this test road the outer wheels of the trucks were kept two feet and six inches from the edge and not a single corner or edge break occurred on that side, except on such sections as entirely failed.

In Wayne County, Michigan, one of the pioneer concrete road builders, such an enormous motor traffic of all kinds has developed that they are being forced to build so-called "Super-Highways" with two parallel forty-foot pavements separated by a space for electric cars and with wide gravel shoulders to permit parking for repairs, tire changes, etc. This is an exceptional case, it is true, but there are many instances of rural concrete pavements of greater than twenty feet in width, and there are several installations of two-way pavements, separated by narrow strips of pavement of a lighter construction and a different color.

A notable installation of this nature has recently been built in Lincoln Park, Chicago, in order to handle the very heavy traffic following the lake front north of the city. To those of us who travel this road, even though it be only seldom, the feeling of relief as we ride over it and the greater speed at which we can safely travel, is worth far more than our individual share in the additional cost of construction.

It is very advisable in the building of future highways that the question of the width of the pavement be given careful study, not only with the idea of handling present day traffic, but of providing for the greatly increased number and weight of motor vehicles that is sure to come. The actual experiences of other states and localities, which are similar to the locations in question, are now available for study, and this will enable the designer to avoid a repetition of mistakes made in the past.

Construction Methods

A study of the third phase, "Construction Methods," reveals many interesting facts and it is only placing credit where credit is due to say that, without modern equipment, devised and put upon the market by the various equipment manufacturers, our present day program of concrete highway and street construction would be a physical impossibility. A comparison of the equipment in use upon the average well organized highway job of today, with that found a decade or two ago, can not but reveal the immense amount of hard work and study required on the part of the manufacturers in order to develop the almost human machines now in use.

One will also be impressed with their confidence in the fact that concrete road building has come to stay and is not merely a passing fancy on the part of a financially interested group of men. They have shown this confidence by the investment of hundreds of thousands in plants and machinery for building road equipment, in the study of the needs, and from this study the constant development of new models and in the introduction and development of entirely new forms of equipment.

Although much of the development of road building equipment has been along the lines of reduced cost of production, nevertheless much has been done toward the improvement of the quality of both the concrete and the finished highway surface. The demands of the engineers and the public for higher quality workmanship have been recognized and much study has been given to the devising of equipment to meet these demands.

In the earliest days concrete pavements were built by hand methods entirely, or by the use of small mixers uncertain in their output and dependability. The aggregates were distributed along the subgrade in piles more or less mixed up with each other, or with the natural dirt and soil of the country, and then conveyed to the mixer or mixing board in uncertain proportions by wheelbarrows and brute strength.

While it is true that these methods, with the exception of the hand mixing, are being followed today in some localities, the demand for quality and quantity production has brought about radical changes all over the continent.

The practice of depositing the aggregates on the subgrade or shoulders having been found to be often productive of poor quality concrete, central proportioning plants were established on many jobs with accurately proportioned batches of clean materials, transported in various manners to the mixer. Sometimes narrow gauge industrial tracks were laid on the shoulders and sometimes trucks divided into several compartments were used for transporting the mixed ingredients.

Logically the next step was the central mixing plant, with the mixer itself taken off the subgrade and all operations carried on at one place, which permits the making of an absolutely controlled product. The mixed concrete is transported in the same manner as are the batch boxes but more often in one batch truck with oversized pneumatic tires, thereby causing the least disturbance of the subgrade. With concrete of the proper consistency, there are no difficulties attending the transportation of premixed concrete several miles.

No one of these methods is applicable to all situations and careful study should be made in each case. In making such a study, however, everything should be considered from the viewpoint of its effect upon the quality of the concrete and the obtaining of a proper subgrade.

Only too often in the past has too little attention been given to the subgrade and as a result uneven thickness of the slab has caused failures. Today, however, much more attention is universally being paid to this important matter and machines have been devised that ride on the side forms and "shave" the subgrade to the exact section and grade required for the new cross-section, as well as for the older types.

As one of the advantages gained as a result of highway test road is the saving in concrete made possible through a more scientific distribution across the slab, it is obviously necessary that the subgrade be carefully shaped and maintained until the concrete is placed. The State of Illinois estimates a saving of $5,000,000 in two years' construction due to this factor, so that it is a refinement well worth rigid enforcement.

But little is to be gained as yet from studies made of subgrade materials that has not been known for years, and as many papers have been written on this subject no attempt will be made to discuss them here. It may be of interest, however, to note that the most satisfactory results have been obtained in swamp and muskeag construction through the use of floating log grills with a slight weight fill over them and by lightweight subgrades well drained on both sides, rather than by attempting to reach stable bottoms with heavy fills.

The development of subgrade finishers and surface finishers riding on the side forms has emphasized the necessity of heavy steel side forms, rigidly held to line and grade by stakes and steel pins. Most of these forms now on the market have wide bottom flanges, but it is often necessary to support even these types

upon wooden stakes of sufficient length and frequency to prevent settlement under the heavy machinery operating over them.

This brings us to one of the most important phases, important not only from the point of appearance but from the point of life of the pavement itself, of the construction of concrete pavements: the finish of the surface.

A review of all the investigations, test roads and experience emphasizes very emphatically the necessity of avoiding impact by all possible means.

We may design and build our pavements with sufficient strength to withstand the dead and rolling loads fixed by law, but it is economically impossible to design for all the impact caused by obstructions or other reasons. This will be appreciated when we consider the fact that an obstruction only an inch in height may cause a static load on a solid rubber tire to be multiplied four or five times. Obstructions of this kind occur less often in country roads than on city streets, except in cases of broken sections or uneven joints, and their effect must be provided for in the factor of safety.

It is the smaller inequalities in the riding surface, due to improper construction methods, that are referred to in this discussion. In the early days the importance of a very smooth riding surface was not realized by many constructors and the all-hand method of building roads did not readily lend itself to obtaining such a surface.

Today, with rollers, heavy strike boards, mechanical finishing machines, longitudinal floats, belts, long straight-edges and rigid side forms available, there is no excuse for poor finishing of concrete pavements. Try out all parts of the surface frequently with a ten or twelve-foot straight-edge and correct the inequalities while the concrete is in a plastic condition. This will avoid the necessity of doing what the State of Illinois is now doing, requiring that all inequalities of over one-quarter inch, as shown by a ten-foot straight-edge on the finished pavement, be bush-hammered down.

In conclusion, it seems advisable again to emphasize the absolute necessity of efficient, well-paid inspectors on all concrete construction. These men should be well grounded in the principles of design of concrete mixtures and in the field operations required to obtain the desired qualities in the pavement. They should understand the proper methods of making test cylinders and what is indicated by such tests.

Incidentally it may be mentioned that the practice of obtaining daily (and even oftener) test specimens of the actual concrete as it is placed in the road, is increasing to a gratifying extent. This practice is frequently being followed, even when there is no attempt toward scientific design of mixtures, in order that a record may be had of actual results.

A few weeks, or longer if possible, training of these men in laboratories, where they can study and understand the effect upon the finished concrete of all the factors entering into its make-up, is a valuable asset for them, and it should be given them whenever possible. They should have authority to prevent anything from taking place that is detrimental to the quality of the pavement and must have the absolute backing of their superior officers.

Finally, don't neglect the curing of the pavement and protection from the air, wind and sun during the early days of its life; cure it properly and double its value.

The foregoing is from an address delivered by Colonel Boyden at the Sixth Annual Road Institute held at Columbia, S. C., February 18, 1925.

REINFORCED CONCRETE RESERVOIR AND PIPE TUNNEL AT CALUMET CITY, ILL.

By Ernest A. Clark, C. E., President Subway Engineering Co., 115 S. Dearborn St., Chicago, Ill.

Calumet City, Ill., formerly West Hammond, is the latest suburb to seek the convenience of Chicago's water supply for its own needs and has signed a contract calling for 2,000,000 gals. per day on a basis of $0.62½ per 1,000 cu. ft. from the Chicago Water Department. This city completes a list of 33 suburbs scattered around the edge of Chicago, which are now being supplied with 17,500,000 gals. of the 838,000,000 gals. of lake water pumped daily by the city of Chicago. The water will be supplied between 1 a. m. and 5 a. m., when the Chicago demand is at its low point, and will be stored in a 2,000,000 gal. rein-

forced concrete reservoir and pumped from there into the city mains as required.

The water will be pumped from Chicago through a 24 in. C. I. main laid through and supplying the districts of Colehour, Ford City, Hegewisch and Burnham, and passing under the Grand Calumet River in a 7 by 7 ft. concrete lined siphon tunnel into Calumet City.

Reservoir

The reservoir is a large, circular, reinforced concrete tank, 180 ft. inside diameter and 13 ft. high, with a capacity of 2,000,000 gals., the floor and roof are 8½ ins. thick and the circular wall 15 ins. thick. Ninety-seven columns 20 ins. in diameter support the roof and fill. The 6 ft. of excavation required for the reservoir was excavated with teams and Western slip scrapers, and was stored on the bank around the tank to be used for backfill.

Concrete for the reservoir was a 1:1¾:3 mix, 1½ in. washed gravel and washed torpedo sand were used for the coarse and fine aggregates. Five pounds of hydrated lime were added to the mix for each bag of cement used, and all concrete was mixed in a 21-S steam driven, side loader (Ransome) concrete mixer.

The reinforced concrete floor slab rests on a sand foundation and was 184½ ft. in diameter and was poured in four sections with joints made of 18 in. wide by No. 13 zinc plate. A footing was placed under the wall 3½ ft. by 1 ft., and under all joints was placed a footing 2 ft. by 9 ins. A sump 7x8 ft. and 5 ft. deep was provided for the outlet pipe, and a reinforced concrete box 7x8 ft. and 5 ft. high resting on the floor was constructed for the inlet pipe. Both inlet and outlet pipes were 24 in. C. I. pipe provided with elbows on the inside of the wall of the reservoir, the inlet elbow turning up and the outlet down. An 8 in. C. I. pipe was laid from the bottom of the sump to the sewer in the adjacent street.

Concreting

Material for the concrete was stored on a plank platform placed on the bank, on top of the excavation, and the mixer was also placed on the bank about 13 ft. above the floor level. Concrete for the floor was spouted from the mixer to a 1 yd. hopper and wheeled from there on temporary runways. The surface of the floor was given a float finish and then covered with sand and kept wet for ten days.

Concrete for the circular wall was poured in two sections with a zinc plate vertical joint and one connecting the floor and side wall. Forms were made of wood with 2x6 uprights spaced 18 ins. apart and 1 in. boards. Circular segments were cut for the uprights to rest upon and to form the circle of the wall. Universal spreader ties were used for wall spacers and ties for holding the forms. After the forms were removed, the spreader holes were filled with 1 to 2 mortar and both inside and outside surfaces of the wall were brushed with a 1 to 2 paint-like mortar to fill all the small air holes, and the wall was kept wet for ten days.

The columns and roof slab were poured from the top, with carts run on a temporary runway resting on the roof form supports. Johnson steel forms were used for the columns. For loading the carts the concrete was elevated with a 24 in. by 28 ft. portable gas driven belt conveyor which elevated the concrete to a yard hopper resting on the roof form supports. The roof was poured in four sections with zinc plate joints. The forms for the roof rested on 4x4 supports, with 4x6 girders and 2x6 stringers and 1 in. floor boards. Four concrete vents were placed on the roof each 30 ins. inside diameter with 4 in. walls, 5 ft. high; these were for ventilation and were covered with a fine mesh bronze screen and capped with a steel hood 5 ft. in diameter. A 4x6 ft. manhole frame and cover was placed in the roof over the inlet pipe.

After the concrete in the roof had set it was covered with 30 ins. of sand and 6 ins. of black dirt. Side slopes of the fill around the reservoir were 1 to 2. Before any backfilling was done the reservoir was filled with 4 ft. of water to test for leaks in joint between floor and wall. None were found after 48 hours and the reservoir was disinfected and backfilled.

Excavation was started Sept. 15, 1924; first concrete poured on October 13, and last concrete poured on Nov. 19, 1924.

The cost of the reservoir was about $90,000. It required 2,200 yds. of concrete, 115 tons of reinforcing steel, 1,500 lin. ft. of zinc plate for joints, 5,000 yds. of excavation, 7,500 yds. of back-

filling and one acre of black dirt and seeding.

Water Pipe Siphon Tunnel

Dredging in the Grand Calumet River necessitated the construction of an inverted siphon tunnel for carrying the 24 in. C. I. pipe leading from Chicago to Calumet City, and the section of the tunnel was made large enough for future gas lines and telephone and light cables.

The size of the tunnel is 7x7 ft. with an arched top and 10 in. walls, the floor of the tunnel sloping 6 ins. to a sump at the South shaft for drainage. At each end of the tunnel is a 10 ft. diameter shaft 60 ft. deep with 18 in. walls. The distance center to center of shafts was made 263 ft. to provide for a 250 ft. channel in the river. Nearly all of the excavated material was taken out of the South shaft and will be used for covering the sand in an adjacent park.

Shafts and Sinking

For the first 15 ft. of the South shaft the excavated material was fine waterbearing sand with few layers of shells and gravel; in the North shaft the excavation was through black muck for about 15 ft. with a layer of gravel and shells just on top of the clay. The remainder of the shafts were through clay, small boulders and small pieces of slate, the clay getting harder and tougher as the shafts were deepened. Open dredging was used in the South shaft to the top of the tunnel and then underpinning from there to the bottom. Little water was found 35 ft. below the surface, though small waterbearing sand pockets were encountered. Below 45 ft. the muck was excavated with pneumatic shovels and hoisted in ½ yd. Western tipover buckets.

Cutting edges were made of 4x4x½ in. angles, and an 18x¼ in. plate with ⅝x36 in. anchors spaced 24 ins. apart, were used for both shafts. Wood shaft forms were used, made in 2-3 feet and one 2 ft. section for each shaft. Forms were left in place for 24 hours and after removal both inside and outside surfaces of the shell were brushed with a 1 to 2 paint-like mortar to fill all small air holes. The walls were reinforced with ½ in. rods 24 ins. apart in both directions.

Equipment for the South shaft consisted of a small Wiley traveling derrick, 11 ft. gauge with a 40 ft. boom, and 7x10 D. D. D. C. American steam hoisting engine with a Dake swinger to handle a ½ yd. Owen clamshell bucket. The North shaft equipment consisted of a 2 ton Sasgen stiff leg derrick, 36 ft. boom, and operated with a 12 H. P. Domestic gas driven D. D. hoist, and, as little water was encountered, the excavation was done by hand to a depth of 40 ft., then pneumatic shovels were used. The shell was concreted upon the top and allowed to sink for about 40 ft. and then was underpinned from there to the bottom of the shaft.

Air for ventilation and for operating the Ingersoll-Rand pneumatic shovels was supplied by a 10x10 Laidlaw horizontal compressor driven by a 40 H. P. Waukesha gasoline engine; a 5x6 ft. air receiver was used for storage. Concrete for each shaft was mixed in a 7-S Universal gas driven concrete mixer, and was placed in the shaft with a ½ yd. Western bottom dump concrete bucket. Water was piped about 1,000 feet from the city water supply. Thirty days were required for sinking each shaft, and the force for each shaft consisted of a hoisting engineer and 6 men.

Tunneling

About 220 ft. of the tunnel was mined from the South shaft, through a hard tough clay containing slate and small boulders. Six feet were mined and concreted on each 9 hour shift. Each shift consisted of a hoisting engineer, 3 pneumatic shovel miners, 2 muckers and 3 top-men. Where sand pockets occurred the tunnel was mined, timbered and concreted in 3 ft. sections. Material excavated was handled in Western ½ yd. buckets set on 14 in. gauge Atlas cars run on a 16 lb. rail track. The buckets were used both for handling the muck and the concrete. Steel ribs were used for forms made of 6 in. 8 lb. channels and made in 2 pieces, with angle iron lugs at top and bottom for bolting together with a 3 in. wood spacing block; 2x6 lumber with beveled edges was used for lagging on the steel ribs. Gravel concrete of a 1:2½:4 mix was used in both shafts and tunnel. Concrete for the tunnel was shoveled and tamped into the forms. After 24 hours the forms were removed and the surface brushed with a 1 to 2 paint-like mortar to fill all small holes.

The 24 in. C. I. pipe was placed in the tunnel on wood blocks. The concrete blocks were cast under the pipe 8 ft. apart. In the shafts the pipe was an-

chored to 7 in. 15 lb. channel spaced 6 ft. apart, with ¾ in. "U" bolts. A 24 in. gate valve was placed in a valve chamber at the top of each shaft. Carbic lights were used for lighting in the tunnel headings.

Each shaft roof was provided with a 24 in. manhole frame and cover and a 4x6 ft. frame and doors. A steel ladder from the tunnel floor to the valve chamber was placed in each shaft.

Engineers and Contractors

The Subway Engineering Company of Chicago was contractor for the reservoir and siphon tunnel, the Public Construction Company of Hammond, Ind., was contractor for laying the pipe, and the Consoer Engineering Company of Chicago were engineers for the work. 19—ADD Municipal Engineering HSH The cost of the siphon tunnel was about $50,000. It was completed in three months.

PRESENTING PUBLIC IMPROVEMENT BOND PROJECTS TO THE VOTERS

By Wm. E. Stanley, of Pearse, Greely & Hansen, Hydraulic and Sanitary Engineers, 6 N. Michigan Ave., Chicago, Ill.

The success of any public project is becoming more dependent than formerly upon the attitude of the people affected by the proposed work. Most major improvement projects require financial support from the people of the community, either by a direct increase in taxation, or by the incurring of a public debt in the form of a bond issue, or subscription to the stock of a public or quasi-public company organized to finance the improvement.

One of the important factors which should be given consideration in connection with every plan for a public improvement today is the method of presenting the plan or project to the people so that they will be thoroughly informed as to what is proposed and why, thus enabling them to judge properly the merits of the proposed project. The voters have the right to demand complete information and it is the duty of the public officials and others who have charge of promoting any improvement to furnish complete information to the voters before the time comes for a vote on a bond issue.

How Projects Develop

In this paper an endeavor will be made to point out briefly how problems develop which require improvement at public expense, how the solution should be determined, general methods of presenting proposed improvement projects to the people concerned, and to give a number of examples where large public improvements have been successfully developed and financed, largely because they were carefully studied and also carefully presented to the people of the community.

A public improvement project may concern the development of an improved water supply, street improvements, works for bettering the sanitary conditions of the community, or many other projects directly affecting the public welfare. This paper will consider principally projects for water supply and for bettering the sanitary conditions of the community, as the writer is more familiar with such works.

The need or desire for public improvements develops because of several general reasons, such as increased growth of the community, demand for better living conditions, improved transportation methods, and so on. In most cases, the need or desire for an improvement is first recognized by a limited number of people who bring the question to the attention of the public officials. As time goes on a greater number of people recognize the need for having the improvement made. If the improvement requires a considerable outlay of money, the community generally faces a rather difficult problem. There is an immediate conflict of desires. On the one hand, the universal desire for a lightening of the burden of public debt and taxation, on the other hand the desire for the benefits of the improvement, or the recognition of the desirability of the improvement.

The first impulse in a great many communities is to temporize with the problem by postponing the solution or by building inadequate works which will take care of the community temporarily or, at the most, for a very few years. This habit of temporizing seems to be quite a universal one with municipal officials and usually results in the expenditure of many times the amount of money that would have been necessary, if the improvements were constructed at the proper time or on an adequate scale.

As the desire or need for an improve-

ment increases, a great deal of discussion takes place and many possibilities are suggested as solutions. Many of these suggestions have real merit. Many others are wild ideas, some quite absurd and ridiculous.

The Engineering Phase

Most, if not all, projects for public improvements are of a nature requiring engineering knowledge and experience for a solution. Often a very extensive investigation and study must be made before the proper solution can be determined. There are local engineers in many communities and a large percentage of the problems which come up are solved by local talent. However, in many cases, the improvement problem is of a nature requiring specialized knowledge which the local man has not had time to acquire. In other cases, the local man is too close to the problem to be able to convince the people or the public officials that he could make an unprejudiced investigation. Outside engineers should be engaged. These engineers should be carefully selected, consideration being given only to those firms specializing in the field relative to the particular problem to be solved. Money paid for engineering services will be saved many times over in the cost of the improvements, if proper qualified and experienced engineers are selected.

The engineering investigation should be extensive enough to give consideration to all the possible solutions which have been proposed. No matter how absurd the proposed solution might be, a reason should be indicated to show why the proposed solution is not tenable. Also, the investigation should develop other possibilities and show which possibility is the proper one to be developed. The results of the investigation should be recorded in the form of a detailed report.

Most engineering reports are read by very few persons. However, a good report will contain a summary of the conclusions and the reasons for the conclusions arrived at, and will contain detailed data and information in a form which can be used by the public officials and others who have the responsibility of explaining the project to the general public so that all questions may be intelligently answered. The report should be sufficiently comprehensive to constitute the basis for all future work.

Financing the Project

After the improvement problem has been properly investigated and a solution worked out, a means must be found for financing the necessary construction work. This usually requires a bond issue or the sale of the stock of a company organized for the purpose of financing the project. In either case it becomes necessary to convince a large number of people of the necessity for the project and that the proposed work will properly solve the problem. This requires some sort of a presentation campaign.

The body of men backing or promoting the public improvement must consist of the public officials, or must work in conjunction with the majority of the public officials. The attitude of this body of men, including the officials, will have a very direct bearing upon the success of the proposed bond issue or stock sale. If they, and especially the public officials, take a passive attitude, that is, an attitude that the people must vote without any explanation of the proposed project, the decision usually will be against the project. The general public will not seek out information of its own accord, and invariably, if the officials do not furnish correct information in a form which can not be overlooked, other agencies will furnish incorrect and generally adverse information, which tends to cast suspicion upon the proposed improvement, and the public usually refuses to support the proposition.

The Presentation Campaign

The detailed methods to be used in presenting improvement projects to the people prior to bond elections or stock sales will vary somewhat for each community. However, a study of methods used in a number of recent cases indicates certain general principles which should be followed.

The leaders promoting the improvement project should make sure that the proposed project is the best solution of the problem. They should thoroughly inform themselves of the details of the project and then endeavor to make every citizen of the community acquainted with what is proposed and why.

One of the first steps in the presentation campaign should be to get the Chamber of Commerce and other business organizations back of the project. This can usually be done by carefully

explaining the proposition to the leaders of the various organizations.

The co-operation of the local newspapers should be obtained and a series of articles published giving detailed information concerning the proposed projects. In this way many people can be reached and explanation made to them as to what is proposed and the purpose of the work.

Maps, posters and other illustrative material should be prepared, exhibits made up and placed at public gathering points. Talks should be made before the various clubs and public mass meetings held in schoolhouses and halls.

Another very effective method of putting the project before the people is by means of the movie houses. Lantern slides showing various details of the proposed improvement should be made up and arrangements made to have them shown on the screen at each movie house for a considerable period prior to the election. Animated moving pictures illustrating the purpose of the project may be used to good advantage.

One of the most important items to consider is the question of opposition. Two forms of opposition may develop—honest opposition and dishonest opposition.

Handling Opposition.

Honest opposition may develop because of mistaken conception as to what is proposed or it may develop because of a conviction that the community can not afford the expenditures necessary to construct the improvement works. The first form can be overcome by careful explanation, if the improvement is meritorious and has been properly worked out. The second form of honest opposition is more difficult to overcome, but can be reduced to a minimum by carefully pointing out the necessity and desirability of the project and indicating what has been done in other progressive communities.

The dishonest opposition may arise from several sources:

(a) Opposition for political reasons.

(b) Opposition of persons who favor some other project because of personal gain which would be received, should the other project be developed.

(c) Dishonest influences of those who oppose clear-and-above board methods of handling the work and who want less rigid plans and specifications in order that the possibilities for graft may be greater.

Dishonest opposition can be stopped at the start by showing it up in its true character.

All forms of opposition should be hunted out and proper explanations made before the opposition gets organized, as it can usually be overcome readily if unorganized, while organized opposition can do a large amount of damage to any cause.

Leadership

Probably the biggest factor which makes for success of a campaign for presenting an improvement project to the public is the amount of energy, enthusiasm and hard work put into the campaign by the men backing the project. There are places where everybody is satisfied that a certain improvement is desirable, but nothing is done, just because no leaders are present with sufficient energy to overcome the inertia of the community.

Full publicity should be given to everything showing the necessity or value of the proposed improvement. The general public should be kept thoroughly informed of the work being done toward solving the problem, even after the funds for financing the work have been advanced. Otherwise distrust and suspicion will be aroused and the people will begin to feel that the money raised is being improperly spent.

The following several examples are here presented to illustrate instances where extensive public improvements have been successfully developed and constructed by funds raised by direct action of the citizens of the communities, because the improvements were properly handled and the citizens were kept thoroughly informed as to the purpose and desirability of the various projects.

Decatur, Illinois

The city of Decatur is located in Central Illinois. It is essentially a city of wide manufacturing interest, but also serves large agricultural interest. In addition there are considerable mining and railroad activities in the city. The growth of the city has been rapid, reaching a population of 31,000 in 1910, and 44,000 in 1920.

The city is located on the Sangamon River, which provides the water supply. Also the sewage and drainage of the

city is discharged into the river. The drainage area of the Sangamon River above Decatur is about 862 square miles.

The growth of the city increased to such an extent that about 1912 the question of sewerage, sewage disposal and water supply became acute. Complaints arose because of the condition of the Sangamon River below Decatur. In 1914 the Rivers and Lakes Commission of Illinois entered an order against the city of Decatur and several of the industries in the city commanding them to discontinue and stop discharging sewage and industrial wastes into said river. The Commission gave the community until Jan. 1, 1917, to comply with the order. In June, 1914, the city requested Messrs. Langdon Pearse and Samuel A. Greeley of Chicago to investigate and report on the sewage disposal problem.

A sewage testing station was built and operated for several months and an extensive study made of the disposal problem. Backed by the findings of this investigation, the city officials and leading citizens, under the leadership of Judge James S. Baldwin, went before the State Legislature and obtained the Illinois Sanitary District Law of 1917. Under this law the Sanitary District of Decatur was formed. Sanitary District bonds and taxes were voted to the limit allowed by law. Intercepting sewers and a sewage disposal plant costing upwards of $1,500,000 have been constructed. The treatment works were put into operation during 1924. These works comprise the largest sewage disposal project in operation in Illinois, outside of Chicago.

The water supply problem at Decatur was equally well handled. In 1918 a bond issue for $225,000 was voted by the people for water supply development, this being the maximum amount which could be raised without passing the bonding limit allowed under the state law. The Sanitary District furnished an additional $100,000 toward the cost of water supply. This amount of money was not sufficient, however, to build the works to furnish the quantity of water deemed necessary for the future growth of the city. Accordingly, in 1920, the Decatur Water Company was formed by the city officials and leading citizens of the community. In 1921 subscriptions were invited for one million dollars worth of stock of the water company. The general public subscribed heavily for the stock, and in five days the million dollars were oversubscribed by $250,000. A water impounding project was constructed costing upwards of $2,000,000.

During the past few years Decatur has also developed a large paving program by local improvement assessments and is now developing by the local improvements assessment plan, sewerage improvements totalling $700,000.

The total value of the public improvements made in Decatur during the past few years and under development at present are approximately as follows:

Water supply	$2,170,000
Sewage disposal	1,500,000
Street paving	630,000
Sewers and drains	700,000
Total	$5,000,000

Total per capita (1920 population), $114.

All of the improvements undertaken at Decatur have been first thoroughly investigated and the best solution worked out. The newspapers have cooperated very extensively and at all times full publicity has been given all projects and the public kept thoroughly informed every day as to what was being done and why. Several special Sunday editions of the newspapers have been published with extensive articles about the improvement projects and large illustrations showing the work being done.

Urbana-Champaign, Illinois

Urbana and Champaign are twin cities located side by side in Eastern Central Illinois. Urbana had a population of 10,200 in 1920, while Champaign had a population of 15,800. The University of Illinois is located on the Urbana side of the line between the two cities. The surrounding country is rich farming land. These two cities have been active rivals ever since Champaign was incorporated, some sixty or more years ago.

The natural drainage of the two cities is from Champaign on the west, eastward through Urbana to an outlet at the east side of Urbana. Many attempts prior to 1921 had been made to solve the mutual drainage and sewage disposal problem of the two cities by funds provided by both cities, but all common bond issue elections failed.

During the latter part of 1920 the leading citizens of the two communities got together and organized the Sanitary District of Urbana-Champaign under the Illinois Sanitary District Law of 1917. After a careful presentation campaign, the citizens of the two cities voted to form the Sanitary District in May, 1921. Sanitary trustees were appointed. These trustees undertook the task of developing a solution to the problem of sewage disposal for the community. A comprehensive and thorough engineering investigation was first undertaken. A detailed report was made by Pearse, Greeley & Hansen, and accepted by the Sanitary District in August, 1922. In November, 1922, a special election was held, at which election a bond issue of $500,000 was approved by a majority of 3 to 1. This was the first bond issue successfully proposed to the two cities. This was no small feat, considering that an intense rivalry exists between the two cities, that bitterness had been engendered by previous bond issue failures and that the bond issue represented a debt of about $19 per capita based on the 1920 population.

The success of the sanitary improvement project at Urbana-Champaign was entirely due to the care with which the proposed solution was developed and presented to the citizens of the combined communities. A large amount of work was done prior to the formation of the Sanitary District by interested citizens and by the Illinois State Water Survey. The final success was due to the presentation of the project to the voters by the Sanitary District trustees. The methods used have been well summarized by Mr. Gustav H. Radebaugh in an article entitled "Solving the City Pollution Problem," in the October, 1924, number of the Field and Stream magazine. Mr. Radebaugh was one of the original district trustees and is now district manager of the Urbana-Champaign Sanitary District. Mr. Radebaugh outlines twelve steps as follows:

1. "Ascertain if any agency is working on the problem; if so, get acquainted with this effort and offer your assistance.

2. "If organized effort is not present, consult an attorney for copies of state law covering stream pollution and care of domestic and industrial sewage, and follow the instructions of your attorney in taking advantage of the law.

3. "Get acquainted with the State Board of Health and the State Water Survey. They will have many suggestions that will be helpful.

4. "The commissioners or others designated by law should secure the services of consulting engineers conversant with sewage treatment problems.

5. "The consulting engineers should make a preliminary survey of the problems to ascertain the real conditions and recommend how to remedy them. By such a report all guesswork is eliminated and the taxpayers will know the real condition they must confront.

6. "Give the taxpayers, through local papers or pamphlets, all the information about the necessary improvement. Have men acquainted with the problem make public addresses.

7. "Enlist the interest of all civic bodies in your district. Let these organized bodies have all the facts. Every citizen has the right to contrary opinions; find out what they are and answer them.

8 "When sentiment is properly crystallized, announce the date for voting on a bond issue to finance the building of disposal plant. List the voting places. Never ask a citizen to vote for the improvement; he is encouraged to vote by receiving all the facts pertaining to the project.

9. "A successful vote on the bond issue is a mandate for the legal officers of the district to proceed with the project.

10. "Commissioned engineers must design plant and prepare specifications. In nearly all states these must be approved by a state supervising body.

11. "Advertise for bids, the details to be governed by law under which the district is organized.

12. "Award the contract and invite public inspection of work, which will insure the support of the public."

The sewage disposal works at Urbana-Champaign were put into operation with a unique public ceremony Nov. 21, 1924, and constitutes the second largest sewage disposal works in Illinois in operation outside of Chicago.

Bloomington, Indiana

Bloomington, Indiana, is located about 50 miles southwesterly from Indianapolis. The population was reported at 11,600 by the 1920 census. The University of Indiana is located at Bloom-

ington. Also the city is the center of a large limestone industry.

The water supply for the city has been inadequate and the city has suffered from periodic failures of the water supply for over 20 years. Some of these failures of the water supply lasted several months, for example in 1922 the city was able to pump water only for three or four hours once a week during the months of October, November and most of December.

Two quite comprehensive engineering investigations and reports were made by competent engineers prior to 1922, the first by Morris Knowles in 1913, the second by Alvord & Burdick in 1920. Also investigations were made by geologists from the University of Indiana. All of these investigations indicated substantially the same solution.

The city officials continued to ignore the findings of these engineers and to spend large sums of money on the old water works until 1922. During 1922 a third engineering investigation of the problem was made by Pearse, Greeley & Hansen. The report submitted recommended substantially the same solution as the previous reports.

Two-thirds of the City Council, together with leading citizens of the city, decided to proceed with the construction works recommended. The Bloomington Water Company was formed to finance the work. A city bond issue of $150,000 was voted to buy a controlling share of the Water Company stock. The remainder of the stock was sold to the public and was oversubscribed in a very short time.

The solution of the water supply problem has been actively opposed by the mayor, the city attorney and the politicians who have been able to keep the mayor in office for many years. Notwithstanding this strong political opposition the promotion of the water supply improvement has been successfully pushed along. An impounding dam, a pumping station and a pipeline to the city are nearing completion. The cost of the construction work is upwards of $275,000.

Complete information has been published during each step of the work and the public kept fully informed as to the work being done with the result that the project has the support of the people, even in the face of the strong political opposition.

Springfield, Illinois

Springfield is the capital city of Illinois and had a reported population of 59,200 in 1920. The city is rapidly outgrowing its water supply and the filth from the sewer outlets is causing pollution troubles. To make the sanitary conditions worse, four large sewers which serve a large part of the city have their outlets into streams above the source of the near future water supply.

During the year 1923, the city officials decided to have a thorough investigation made of the sewage disposal problem. A comprehensive report was submitted jointly by Pearse, Greeley and Hansen of Chicago, and Dawson and Walraven of Springfield in January, 1924. This report covered every scheme proposed as a possible solution. The relative merits of the various possible solutions were studied and the solution which was deemed the best was recommended.

In accordance with the recommendation of the engineers the city officials decided to organize the Springfield Sanitary District. An extensive educational campaign was conducted and as a result, the voters at a special election in April were five to one in favor of the organization of the Sanitary District. Trustees were duly appointed and decided to proceed with the construction of the proposed work as rapidly as possible.

The total cost of the proposed construction is estimated at 2¼ million dollars. To finance this work, a bond issue of 1½ million dollars and an increase in the Sanitary District tax rate was found to be necessary.

The district officials continued the educational campaign started by the city. During the summer and fall of 1924, a very extensive campaign was conducted. The Chamber of Commerce and other civic organizations were induced to give active support to the proposed improvement. The cooperation of the newspapers was enlisted. Long articles were printed explaining by progressive steps what the Sanitary District proposed to do and the good expected to result. The moving picture theatres were induced to show lantern slides and animated pictures showing how the proposed works would better the sanitary conditions. As a result of the extensive campaign conducted, voters at the November election approved the bond issue by a large majority. Construction plans and specifications are now being prepared for the first contracts.

There are many other examples which might be cited where funds have been provided by large popular votes, because the merits of the proposed projects were carefully presented to the people.

There are also many examples where the people have refused to vote necessary bond issues, largely because no one took the trouble to present the merits of the proposition to them. In a few instances, bonds have been voted without full explanation of the improvement because the people knew something had to be done, but usually when this happens, a lot of the people are distrustful of the improvements and probably feel that they are being cheated, where as a matter of fact, they may be getting good returns for their money.

The foregoing paper by Mr. Stanley was presented at the 1925 meeting of the Iowa Engineering Society.

FACTORS AFFECTING CONSTRUCTION EFFICIENCY AND INFLUENCE OF SPECIFICATION INTERPRETATION ON COSTS

By T. J. Wasser, Civil Engineer, Public Service Production Co., Newark, N. J.

The writer in presenting this paper will endeavor to state what, in his opinion, are the factors affecting efficiency in construction organization and influence of specification interpretation on unit cost of highway construction.

Direct Factors

A careful investigation of the subject indicates the necessity of dividing the factors into two classes; namely, direct factors, or those solely within the jurisdiction of the construction organization, under an individual, central control and involving primarily a smooth, efficient, working organization with sufficient capital, credit and experienced supervision to operate economically a suitable modern well-maintained, construction plant.

Any deviation from the above conditions is not considered when bidding on work; for instance, to carry out the efficient working of the organization a standard of progress for each item of the project is fixed after the investigation has been made and before the estimate has been made up.

Should the organization be successful in securing the contract, the construction force of the organization endeavors to maintain the standard of progress and cost fixed at the time of bidding. Any of the direct factors affected adversely during the progress of the work, due to inefficiency of the organization, will increase the unit cost, but being solely accountable for them, the organization must assume the responsibility and the contract is completed at a reduced profit or complete loss.

Indirect Factors

The indirect factors, however, over which the construction organization has no control involve the engineering, production of materials and railroad transportation. These play a very important part in the progress of the work; the several indirect factors not being under one central control, do not function collectively as efficiently as the construction organization, and hence cause delay which is generally made up of a number of short stoppages on interferences which when summed up at the completion of the contract, has been found to add considerably to the unit cost.

Other Factors

The two classes of factors herein stated are also affected by elements that are unpreventable and non-determinate conditions, which develop in the progress of the work; namely, stormy weather over normal conditions; delays and suspension of work due to railroad embargoes and severe storms that destroy both completed and uncompleted work.

The highways improved or otherwise are the property of the state and at all times subject to damage by the elements, with the exception that the state is temporarily relieved of the responsibility during the period of construction by virtue of the contract and the construction organization is required to assume this obligation during that period. With this in mind, it is not unfair on the part of the construction organization to request a prompt final inspection and acceptance following the completion of a contract.

The writer has in mind a contract that was completed and reported to the highway department; a date for final inspection was set but during the intervening time, a severe storm occurred damaging the shoulders of the work which made it necessary to postpone the date of final inspection until the contractor at his own expense, could replace

the damaged work. Furthermore, on this particular contract, it was necessary to replace the shoulders a second and also a third time for similar reasons before the final inspection was made and the work accepted. This condition affected the unit cost considerably.

Organization Requirements

The writer has already stated in a general way the direct factors which enter into the efficiency of a construction organization and will now endeavor to analyze the statement. First of all capital and credit to enable the organization to function are paramount after which the personnel of experience is absolutely necessary for the organization to function efficiently: Type and personality of field superintendents; their ability to deal with engineers in charge of work; direct the forces under them; their knowledge of operating and repairing plant; their ability to deal with the public in a business-like manner; their aptitude in selecting labor and efficient equipment operators and keep a following of such men from job to job; their knowledge of commissary operations in order to keep men well fed and satisfied to prevent labor turn over and finally their alertness to get construction results.

Assuming that such an efficient organization exists, a representative of the organization proceeds to investigate a project, and, in so doing, it is his duty to secure from the engineer a copy of the plans, specifications and such other information as may be available, he then visits the site, makes his observation and submits a report to the head of the organization covering the information which it was possible to obtain on the conditions governing the several items of work included in plans and specifications of the project and the available plant sites.

Detail of Items

This report is in the nature of a general description of the location of the project and a detail of the items as follows:

Excavation and Grading.—Character of excavation and percentage of rock determined by observation of out-croppings and previous cuts made. If one or more large cuts are to be made, he gives the character of each separately and disposals. If new road is on line of old road, he gives condition and materials of old road.

Borrow.—If required, where it can be procured, stating character of borrow pit and the grade and condition of the road leading to the pit.

Plant Sites.—Location of sidings, car capacity of same, length of dead haul to job, condition and grade of road hauled over, the rate and hours per day for teams and motor trucks, whether or not industrial equipment can be economically used.

Water Supply.—Source of supply and location of same. If local water mains parallel road and plugs may be used, he secures the name of the company and location of its office.

Local Materials.—Location of quarries and sand pits; what would be necessary to make use of them.

Equipment.—Type of equipment best suited for the conditions to be encountered.

Labor.—Available source of local labor, rate of pay, whether or not it will be necessary to establish a camp or commissary.

In addition to the above information, the report covers the following:

The condition of existing bridges within the limits of the operation, their clearances and carrying capacity.

The location of existing grade crossings within the limits of the operation.

The location of available railroad sidings, their length, condition and necessary repairs or extensions recommended.

Frequency of railroad deliveries and drill service.

The detours which are necessary, their condition and who maintains them, stating the estimated cost to keep them in condition for traffic.

Anticipated delays.

Following the approval of the report, the material sheet is made up and quotations asked for after which the estimate is prepared and the proposal submitted to the highway department.

Assuming that the organization has been successful in securing the contract, the care with which the project has been investigated, has been brought out in this paper solely for the purpose of conveying to your mind the procedure necessary to be followed in order to prepare an intelligent bid and at the same time impress you with the effect it must have on those in charge of the construction forces of the organization to know that the unit cost, as estimated, is based on all the available information obtainable.

Excavation and Borrow

Yet, to the writer's mind, the information regarding excavation and borrow is anything but complete and it is principally these two items alone which are affected by the increase in unit cost, because it is necessary to accept the quantities, as stated, as being correct without sufficient time, opportunity or disposition to check them although it is known that the quantities stated contain an assumed amount to allow for shrinkage. This assumption would not materially affect the unit cost were it not for the fact that the engineer in his design endeavors as nearly as possible to balance the job between cut and fill, but invariably showing a small plus in excavation. It is then that the shrinkage enters into the unit cost very materially; shortage of material claimed by the contractor is invariably met with the statement that material was wasted, so the superintendent, in charge of construction, has to see all slope stakes are left intact even after the excavation has been practically completed to sustain any claim he may have for shortage. If the material from a cut fails to complete a fill, as shown on the plans, then the making up of the deficiency from another source is always at a greater cost, but the organization is paid the unit bid price.

Excerpts from Specifications of Three States

It might be well at this time to cite excerpts from specifications of three states, covering the items of excavation.

1. *Excavation and Embankment*

Description: Excavation and embankment shall consist of grading the roadway in conformity with the drawings, true to lines and grades given. This grading shall include all clearing and grubbing, removing structures, obstructions, etc., as indicated or directed, excavating, forming embankments, shapang and sloping, compacting and other work that may be necessary in bringing the roadway and its appurtenances to the required grade, alignment and cross-section, also the grading of all intersecting roadways, driveways and approaches, and excavating all foundations for structures. This work shall be done in accordance with these specifications.

Basis of Payment

Payment for the foregoing work will be made as follows:

(a) Excavation: All "roadway excavation", including the widening of cuts and the increasing of slopes, excavation of intersecting roadways, driveways, approaches, ditches, waterways, slides and all excavation for structures except when specifically stated otherwise, will be paid for at the contract unit price per cubic yard for excavation, which price will include all excavation within the limits of the highway and all ditches, channels, etc., appertaining thereto, formation of embankments, disposal of surplus material, trimming of slopes; also all clearing and grubbing, the removal, unless otherwise specified, of all structures and obstructions and the furnishing of all equipment, tools, labor and work incidental thereto.

Excavation for structures will include the re-filling of the excavated areas not occupied by the structure to the level of the original ground. No separate compensation will be made for cofferdams, bracing, shoring, pumping or bailing, or for material used on account of encountering water, but the same shall all be included in the unit price paid for excavation.

Excavation below the finished subgrade surface, of rock ledges, boulders and unsuitable materials other than those included in the clearing and grubbing, excepting where such materials have been placed in the embankment by the contractor, will be paid for at the contract unit price per cubic yard for excavation, which price will include the removal and disposal of the material, as directed, and the re-filling and compaction of these materials. The materials used in the refilling shall be taken from the excavation.

Special attention is called to the method of payment of excavation for miscellaneous drainage, structures, pipe culverts, etc., as specified in paragraph headed "basis of payment" under the specifications for each kind of structure. No specific payment will be made for clearing and grubbing or for the removal of structures and obstructions except as specifically stated herein or otherwise specified.

(b) Borrow: All borrow excavation required for the completion of embankments within the limits of the work will be paid for at the contract unit price per cubic yard for "borrow" complete in place, which price will include the furnishing and placing of the material and all equipment, tools, labor and work incidental thereto. This shall include for-

eign borrow used and measured as herein provided.

(c) Subgrade Stone: All additional stone used for bringing an old telford or stone road to the required subgrade surface, as directed, shall be paid for at the contract unit price per cubic yard, loose measurement, for "subgrade stone", which price will include the furnishing of the materials and the placing thereof, together with all necessary equipment, tools, labor and work incidental thereto.

(d) Subgrade: The subgrade shall be paid for at the contract unit price per square yard of completed subgrade, which price shall include all scarifying and shaping; the preparation, wetting and protection of the subgrade. The subgrade shall not be paid for until the base course or pavement has been constructed thereon. The area upon which payment for subgrade will be based will not extend outside of the base course or pavement. Special compensation will not be made for the shaping and finishing of intersections, approaches, private driveways, or the rolling of the area 12 ins. outside of and adjacent to the edges of the pavement.

(e) Shoulders: The shoulders shall be paid for at the contract unit price per linear foot of roadway of completed shoulders which will be paid for when the shoulders are finally completed and accepted. Payment for shoulders will not be made until both sides are completed as required.

2. *Excavation and Embankment*

Roadway Excavation: The roadway excavation shall include the removal and disposal, in the manner herein required or as may be ordered by the engineer, of all materials taken from within the limits of the work, that are necessary for the construction and the preparation of the roadbed, embankment, subgrade, shoulders, slopes, gutters, ditches, waterways, intersections, approaches, private entrances, etc., as herein defined. Grading shall not extend beyond the limits of the roadway, except where otherwise shown on drawings or ordered by the engineer. All suitable material removed from the excavation shall be used as far as practicable in the formation of the embankment subgrade, shoulders, etc., and at such other places as directed. All breakage and slides shall be removed by the contractor and disposed of as directed. Ditches and waterways shall be excavated to the depth and width shown on plans, or as may be directed. No excavated material shall be wasted without permission, and when such material is to be wasted it shall be disposed of as directed by the engineer. No payment will be made for any excavated material which is used for purposes other than those designated herein. During the construction of the roadway the roadbed shall be maintained in such a condition that it will be well drained at all times.

If the engineer shall permit the contractor to widen a cut at any point in order to secure extra material, such extra excavation must be made to the line, grade, and cross-section as the engineer shall direct and the slope shall have the same treatment as though no such extra excavation has been made. If the engineer shall permit the contractor to deposit excess material in spoil banks within the highway, such material must be deposited to the line, grade and cross-section as the engineer shall direct. All such extra excavation or embankment shall be finished in a neat workmanlike manner, and must not be left in an unsightly condition.

Excavation in both rock and earth cuts shall be sufficient to permit of the proper execution of the work and installation of all equipment required. The face of all rock cuts must have a fairly uniform surface, free from all loose stone, shattered edges or other conditions that will render them unsafe.

Basis of Payment

Earth Excavation: All earth excavation will be paid for at the contract price per cubic yard for earth excavation as given in the proposal. This price will include all labor, equipment and materials necessary for the excavation, as herein required, of the roadway, intersecting roadways, entrances, driveways, approaches, and all other excavation not otherwise classified or shown on plans. It will also include the formation of embankments, disposal of surplus materials, and the preparation and construction of earth shoulders and subgrades for the pavement, paved shoulders, gutters, intersecting roadways, driveways, entrances, approaches, etc., unless otherwise specified.

3. *Common Excavation*

Description: Common excavation shall include all decomposed rock, shale, hard pan, earth, clays, loam, sand, gravel,

soft sandstone, soapstone, loose stone in masses and all boulders measuring less than 1 cu. yd. in volume, and all material which is not included in the specifications for "solid rock excavation".

Excavation shall consist of grading the roadway in conformity with the plans and profile, true to the lines and grades given. This grading shall include all excavating, forming embankments, compacting same, shaping and sloping, the removal and proper disposal of isolated trees, hedge rows, fences, pipes, steps, walls, and other work that may be necessary to bring the roadway and its appurtenances to the required grade, alignment and cross-section, also the grading of all intersecting roadways, driveways, and approaches and excavating all ditches except as specified under "drainage ditches".

Sod, grass, weeds, and other objectionable matter shall be removed from within the limits of slope stakes on fills of 2 ft. depth and less, but the contractor shall not receive any compensation for this work, nor for the grubbing of orchards and lone trees within said slope stake limits, it being understood that his compensation will be covered by the increased amount of material going into the fills, due to the removal of said sod, grass, weeds, or other objectionable matter, which material is fully covered by the unit prices for regular excavation or borrow.

Fences or pipes which are to be reused shall be removed with care and piled or disposed of in a manner acceptable to the engineer.

The rebuilding of fences and moving of houses and other buildings will be paid for under the item covered by "extra work" as described elsewhere in these specifications.

Basis of Payment: All excavation will be estimated and paid for at the contract unit price per cubic yard for "excavation", which price shall include the removal of all obstructions as specified under "common excavation" within the limits of the right of way, the formation of embankments, refilling around structures, and the disposal of all surplus material, preparation of subgrade, shoulders and ditches.

Non-Determinate Conditions

One has only to bear in mind the above quoted specifications and note the several distinct operations required under the item of excavation to realize fully the non-determinate conditions. Aside from that, under the item of excavation, the work involved, includes from rough machine work to fine hand work without any indication of how much of the latter will have to be done.

There are so many specified conditions without any quantity being stated that the estimate on the item of excavation is partially made up of assumptions with the hopes that the total work can be done for the price bid,—it being borne in mind that if every condition included in the item of excavation were figured on, the organization so doing would seldom win a contract.

That "Etc." Costs Money

Take for example the following which appears on a proposal prepared by a State Highway Department and represents the item of excavation:

"Cubic yards of 'excavation unclassified' including all materials of whatsoever nature encountered; also, including clearing and grubbing, the removal of trees less than 6 ins. in diameter; the removal of structures, obstructions, etc.; resetting of wooden steps, and entrance posts; the formation of embankments, subgrade and shoulders; ditching; scarifying existing road surface where required; shaping and trimming of slopes; disposal of material and incidental work."

In the execution of a contract containing an item such as above described, one is bound to an obligation not only to do the work definitely specified, but also all incidental work which the engineer considers covered by the "etc."

For a Broad Literal Interpretation

The writer in his short experience has had very little trouble in interpreting specifications, but from his observations, he feels that a lot of unnecessary waste of money could be saved and the results desired obtained if the engineers and the field forces would interpret in a broad sense the literal meaning of the specifications. True, the present specifications have been added to from year to year until now they cover every possible condition that can arise, and to comply with them at the price one is required to bid, to secure the contract, it is necessary that the specifications be interpreted in a practical manner.

Conditions to Avoid

Inspectors should avoid argument with contractor's superintendent but at the same time refer any difference in inter-

pretation of the specifications to their immediate superiors, requesting a decision on the point at issue.

The additions to the specifications have been made necessary by misinterpretation in years gone by and each year additional conditions, although not definitely stated, have been included under the original item of work and keen competition by the ever-present inexperienced contractor prohibited others from bidding a price which would net a profit.

Having in mind that highway construction represents an expenditure of public moneys, it is not expected to make radical changes in the specifications which could be construed as favoring a contractor. It is only desired to remove from the items specified, that which a definite quantity of the work to be done cannot be specified in the item, and to provide a separate item for such work.

Get the Right of Way First

Aside from the specifications, some of the indirect factors affecting the unit cost of the work which could be eliminated by the engineer are the awarding of a contract without having acquired the full width of right-of-way as shown or noted on plan.

Avoid changing line and profile of the road after construction work has been started. Such changes have been made at time when the cost of doing the work exceeds the price bid for the item of work.

Should it become necessary to change line and grade of road, then same should be paid for under supplemental agreement.

When changes in plans and specifications are made involving a reduction order, all material on hand for account of work eliminated, should be paid for including whatever expense is connected with it.

Extra work orders requiring material to be purchased should be issued sufficiently in advance as not to delay the progress of the contract work. After, say, 75 per cent of the contract work has been completed, all extra work requiring the purchase of material should be ordered by supplemental agreement to avoid delay and expense in completing work. Unforeseen conditions arising on work such as the use of sub-base material should be determined on without delay. The use of this material could be determined at the time the shovel is engaged in the excavation and not wait until the fine grade is being prepared.

Variation in Thickness of Pavement

A permissible variation in thickness of pavement should be allowed by specifying as necessary the minimum thickness and paying for additional thickness, say an additional fraction of an inch. Under present methods of construction using the most modern highway equipment, it is impossible to construct a pavement of the exact thickness as now specified.

A permissible variation in fitting sections of road forms should be specified for line and grade, as it is at present the personal equation of the inspector predominates which has considerable effect on the progress of the work.

Inspectors should not be permitted arbitrarily to shut down the work. This order should come, if necessary, from at least the division or district office of the department.

Embankments and Shoulders

In specifying how embankments should be made, a permissible variation in width on top should be provided for by stating the minimum width and paying for actual width up to say one foot wider. Under present conditions, it is impossible economically to construct a fill to a neat line. If additional material has to be added, it is expensive unless put in at the proper time; if too much has been put in, it is considered waste and not paid for.

The finish of shoulders at present requires too much hand work. The specifications should require the shoulders to be made from material excavated (unless other material is specified) of full size section as shown on plan, compacted by rolling with roller or by the use of other approved type of equipment which will produce a compacted shoulder of full section.

Standard Drawings

The use of standard drawings for structures has, in many cases, added considerably to the unit cost, but the increase in cost was due to the misinterpretation of the drawings by the field forces rather than to the use of standard drawings. It is only after the forms have been placed that many inspectors can see whether or not they fit the location and changes in form work where the cubic yards of concrete involved are small, are quite expensive.

Material Market

The material market each year pre-

sents its difficulties especially the production of the coarse and fine aggregates for use on the work. Some producers oversell their capacity and in their effort to supply the demand suffer from rejections due to variation in grading from that required by the specifications. In every case where rejections occur, the construction organization becomes a partner to the loss. When action is delayed by failure of the engineer to render a prompt decision and the material is finally accepted then the construction organization assumes the total loss. In either case the unit cost of the work is increased.

I have cited these aggregates because of all the materials used in highway construction there has been little or no trouble with the others and I feel an effort should be made by the representatives of the highway department here assembled to do their share towards overcoming the difficulties of the stone and sand producers.

Compare your specification requirements for these materials and you will note that material which will meet the requirements of one state would be rejected in another, yet both states are carrying on successful road programs.

You should bear in mind that the construction organization in placing orders for this class of material is subjected to limited competition and delays in the production of this material for any reason whatever is very expensive and adds materially to the unit cost.

Railroad Delays

Railroad transportation of materials has been very satisfactory except when affected by embargoes. In this matter some of the railroad station agents have been too keen in reporting to their superiors about congestion of freight and they do not fully realize the rapidity with which materials can be handled by the contractor. Congestion of freight conditions is due to any one of many causes that delay the construction work, but the effect of the embargo is felt when the railroad company will not permit movement of cars to that point until all cars are unloaded, thus causing a gap in the construction work of from two to three days in addition to the time originally lost which caused the embargo. Losses from delays of this nature add considerably to the unit cost of the work.

In conclusion, I would say that any action taken on the part of this association in appointing committees who will submit recommendations standardizing requirements of materials, methods of construction and uniformity of specifications, may consider its work well done, as it is a known fact that standardization is the greatest element in the reduction of cost in manufacturing, engineering, and construction and the writer can see no reason why it is not applicable to highway work.

The foregoing paper by Mr. Wasser was presented at the first annual convention of the Association of Highway Officials of the North Atlantic States, recently held at Atlantic City, N. J.

RAIL, WATER AND HIGHWAY TRANSPORTATION AS VIEWED BY RAIL ENGINEERS

By Robert H. Ford, Assistant Chief Engineer, The Chicago, Rock Island and Pacific Railway Co., La Salle St. Station, Chicago, Ill.

Transportation is the lifeblood of the nation. It affects favorably or adversely the existence and fortunes of every human being as it prospers or declines.

Originally an occupational and adventurous pursuit, it has become, in our intensely organized social structure, a highly developed science in which "adventure" has been replaced by "fascination," which attracts and holds its operatives in its highly specialized service; they function like the soldiers of a vast army, affected all alike from general to private, or in railway parlance, from president to trackmen. It consists of a closely-knit organization of highly skilled persons who outwardly appear to function as a loosely arranged body, but who, in reality, operate as a vast human machine.

Transportation has developed through three great agencies—highways, waterways and canals, and the railways. What its industrial possibilities in the air may be, remains to be determined.

Even before the Constitution of our Federal Government, Washington had organized a company for the improvement of navigation on the upper Potomac in connection with a highway across the Alleghenies to the navigable rivers of Ohio, and when, later, the Erie Canal was completed, real impetus was given to this improved form of transportation, to be followed by the railways as canal auxiliaries or, in effect, as connecting

links to what was then the principal medium for transportation.

The Canals

For a time, canal construction advanced rapidly, until over 5,000 miles had been built, the greater part of which has long since been abandoned. Meanwhile the railways rapidly passed from the position of auxiliaries or connecting links to the position of the dominant transportation agency.

It seems incredible that relatively but a few years ago, it was unlawful for the railways to carry freight except in the closed season when the canals were frozen over and it was impossible to ship other than by rail, the railway being considered principally as a medium for the transportation of passengers, its relative merits being summed up by a select committee from the Illinois Legislature, who reported:

"The Committee are not insensible to the benefits arising to the country from the completion of well-planned railroads. But they have no difficulty in coming to a conclusion to prefer canals over railroads. We know that a few years since, opinion inclined to favor railroads in preference to canals, but well may the committee remark, in the language of a clear-minded statesman, 'that time and experience seem to have tested the comparative value of these two modes of facilitating the commercial intercourse of different regions, and public judgment has settled down in favor of canals in preference to railroads.' . . . The Committee would urge as a preference of canals over railroads, that the former are not proposed to be used and cannot well be used as monopolies which are so repugnant to the feelings of a large majority of our citizens. . . . Their use is necessarily confined to a few . . . and subject to the pleasure of a company of their supercilious agents."

Meanwhile, the American railway system has developed to over 250,000 miles, while the canals have passed as a factor for internal transportation. There are some who believe that these internal waterways may yet come back, and to this end, various schemes for vast expenditures of public money are being promoted by politicians and others, because private capital has long since recognized the retirement of the canal as a remunerative medium of transportation, and it can, therefore, be continued only by artificial means requiring annual subsidies of the tax-payers' money.

The Hudson River, between New York and Albany, is probably the best example of a natural inland waterway. This magnificent stream, with New York, one of the greatest commercial and industrial ports in the world, as one of its termini, and Albany, the other, providing direct access to one of the greatest agricultural, industrial and manufacturing sections in America, without canal lock or toll, is utilized by no traffic of consequence. Practically the same situation prevails for the great New York State Barge Canal, for whose construction over $100,000,000 was assessed against the tax-payers of New York, requiring, exclusive of maintenance costs, an interest charge for construction alone, or about $1,700.00 per day. These are but examples of the passage of the canal as a potential factor of inland transportation.

Railway Evolution Still Going On

Although the railway has long since become the essential transportation agency, it is a curious fact that the general public seems unaware that it is still in the process of evolution, which may be divided into five principal stages, as follows:

1. The tentative, or embryotic, stage, or period of experiment with a mode of of transportation whose potential influence as a public service had not yet become apparent.

2. The stage of its extension, when confidence had been acquired in its permanent value as a factor in our social, political and commercial life.

3. The stage in which the principal framework of the system was substantially established and in which it was found necessary virtually to reconstruct the system in order that it might reach the centers of increasing population and production, and the resulting commerce of the country.

4. The stage in which restrictive regulation, arrestive development, and destructive action became a predominant factor in the system.

5. Finally, the present and, we trust, constructive stage, as, through the medium of the Federal Transportation Act, this great transportation machine is emerging as a vast industrial agency in which science and invention, on the one hand, and economy and efficiency on the other, are now endeavoring to work in close harmony along sound basic principles of economics, to the end that the

interests of the investor and the public will alike be conserved and protected, the former, by a fair return on the outlay which makes possible the greatest use and benefit of this agency and the latter (made up of every individual in America, irrespective of his station in life), by the maximum of commerce and service at the lowest cost. The interests of all are identical, viz.: To obtain all the benefits of the best form of transportation at the lowest cost.

Now Comes the Automobile

As the canals first linked and then, in a figurative sense, competed with, the highways, and the railways linked, and later competed with, the canals, so, in turn, has the automobile, with the support of improved public highways, entered as a competitor of the railways, and there are unmistakable evidences that the history of American transportation will again repeat itself in unfortunate and excessive expenditures for economically undesirable competitive development. This will require large sums of public funds to be expended, and will create conditions that affect directly every person by adding greatly to his taxation burdens, in order to provide for these duplicated forms of transportation, both of which must thereafter be maintained and supported, whereas if the economies of both were properly studied and understood, the desirable attributes of both could be jointly co-ordinated and developed, the results would be the converse, and the tax-payer would reap the direct benefits through a decrease in State, Federal, and other taxes and charges.

The Tax Burden

One of the greatest curses that the American public is suffering from is the insidious increasing burden of taxation. I believe I am conservative in my statement that there is only a negligible number of persons who can unravel our complicated schemes of direct, semi-direct, and indirect taxation in such a way that the individual tax-payer can know how, where, and to what extent he is taxed, or so that he can grasp the actual effect that it has on the life and fortunes of himself and his family. The sinister effect of this is reflected in all forms of our industrial, social, commercial and, I may safely add, even our spiritual, life. One of its direct results has been to so fog and becloud the transportation problem that unless intensively studied in all its aspects, the average citizen is totally unable to differentiate between necessary rates and those excessive and unnecessary charges which come as the result of duplicated public agencies or unwise development, always in the guise of a public improvement, and to which he is so often the innocent aid as well as the unfortunate victim. It is his money that must thereafter pay for its support, and provide for additional squads, companies, or regiments at the public trough.

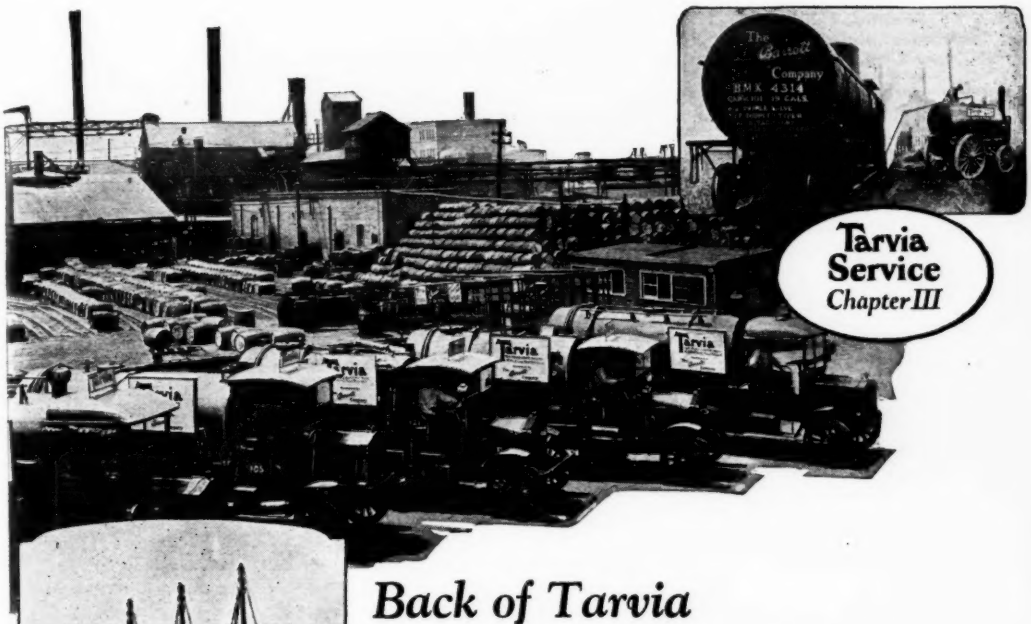
No one will dispute the principle that the public has a right to expect that its individual and his goods shall be transported from one place to another at a cost to him which shall have for its measure, the highest degree of economy and efficiency in performing the service, with a fair return to the owner or investor furnishing the facility. To accomplish this plainly requires that all associated public agencies of whatever character shall be co-ordinated with the main artery or transportation agency.

Railway Transportation

An analysis of railway transportation points irresistibly to the fact that a large part of its costs are unnecessary and against the public interest, whereas if properly co-ordinated, a great reduction in transportation rates would be ultimately secured. To accomplish this, however, requires, even more, demands, that some means be found whereby these various Municipal, County, State, Federal, and other agencies shall co-ordinate effectively with the national transportation agency.

Transportation by railroads succeeded transportation by canals for no other reason than that it was cheaper and more effective to move persons and goods by rail than by water. It merely followed a natural law of economics that, when, unhampered by some artificial means, traffic will flow along the lines of least resistance which, in this case, means by the quickest and least expensive route. These may, for a time, be altered by artificial means, but as soon as the bolstering effect is removed, whether it be through subsidies of public funds or otherwise, traffic will ultimately turn to these economic routes. These artificial means can only be sustained at public expense because private capital will not support anything that cannot support itself.

(To be concluded in April issue.)



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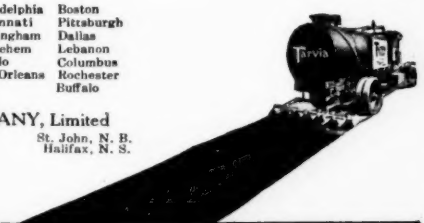
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